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CURRICULA ET EVALUATIUON

POLICIES FOR THE DIGITALISATION OF SECONDARY EDUCATION: FACTORS INFLUENCING SUCCESSFUL AND SUSTAINABLE DIGITALISATION

Thesis submitted in partial fulfilment of the requirement for the award of a Master's of Education in Educational Management.

Specialisation: Educational Management Information Systems

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Date: **12 of July 2024**

Declaration

I, **NFOR NGALA NELSON**, do hereby declare that this thesis is my original work and that it has not been and will not be submitted for any academic award at any other university for a similar or any other degree award.

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Signature

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Date

Certification

The undersigned certify that they have read and hereby recommend for acceptance by the University of Yaounde I, a thesis entitled “Policies for the Digitalisation of Secondary Education: Factors Influencing Successful and Sustainable Digitalisation”, in partial fulfilment of the requirements for the award of a Master’s Degree in Educational Management from the University of Yaounde I.

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Dedication

To my mentor Mr. Fomboh Julius Fombutu.

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List of Abbreviations

AI	Artificial Intelligence
API	Application Programming Interface
AU	African Union
CENADI	'Centre National du Développement Informatique'
CGEB	Cameroon General Certificate of Education Board
DCIT	'Direction centrale de l'informatique et de la téléinformatique'
DE	Distance Education
DECC	'Direction des Examens, des Concours et de la Certification'
DIT	Department of Information Technology
EMIS	Educational Management Information System
ERP	Enterprise Resource Planning
EU	European Union
GCEB	General Certificate Education Board
GESP	Growth and Employment Strategy Paper
GNAT	Ghana National Association for Teachers
HR	Human Resource
HTTC	Higher Teachers' Training College
ICT	Information and Communication Technology
ILO	International Labour Office
IMF	International Monetary Fund
IT	Information Technology
LMS	Learning Management System
MINDDEVEL	Ministry of Decentralisation and local Development
MINEDUB	Ministry of Basic Education
MINEE	Ministry of Water Resources and Energy
MINFI	Ministry of Finance
MINEFOP	Ministry of Employment and Vocational Training
MINEPAT	Ministry of Economy, Planning and Regional Development
MINESEC	Ministry of Secondary Education
MINESUP	Ministry of Higher Education
MINPOSTEL	Ministry of Post and Telecommunications
MoE	Ministry of Education

MRC	Multimedia Resource Centre
NAICT	National Agency for Information and Communication Technology
NDS30	National Development Strategy 2020-2030
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organisation
NSC	National Statistics Council
NSDS	National Strategy for the Development of Statistics
OBC	'Office du Baccalauréat du Cameroun'
OECD	Organisation for Economic Cooperation and Development
OER	Open Educational Resources
OLPC	One Laptop Per Child
OLPT	One Laptop Per Teacher
PATNUC	'Projet d'Accélération de la Transformation Numérique au Cameroun'
PD	Professional Development
PMI	Project Management Institute
PTA	Parent Teachers Association
SDG 4	Sustainable Development Goal 4
SELFIE	Self-reflection on Effective Learning by Fostering the use of Innovative Educational technologies
SIGIPES	'Système Informatisé de Gestion Intégrée du Personnel de l'Etat et de la Solde'
TI	'Technologie de l'information'
TRB	Telecommunications Regulation Board
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNICEF	United Nations International Children's Emergency Fund
USSD	Unstructured Supplementary Service Data
VLE	Virtual Learning Environment
WEF	World Economic Forum

Abstract

Digitalisation has been a buzzword since the 2021–2022 academic year in the Ministry of Secondary Education. The advent of the COVID-19 pandemic and the subsequent shutdown of schools was a clarion call for the necessity of accelerating the integration of technology into education. But such a goal demands appropriate infrastructure, intensive professional development, detailed planning and coordination, and the application of best practices. If a plan with elements to promote best practices and deter poor practices is not established, then the digitalisation of Secondary Education will be a pie in the sky. The purpose of this study is to identify the digitalisation endeavours implemented in MINESEC and the factors that influence a successful and sustainable digitalisation of education. We thus had as objectives to provide a comprehensive list of digitalisation endeavours instituted by MINESEC; identify pain points; and recommend ways to mitigate these pain points. To achieve these objectives, a qualitative study was conducted with a case study research design. Data was collected through observation, study of official reports, policy documents, literature reviews, and interviews. The sample for the interview was chosen based on fit for purpose. Content and narrative analysis were used to get the results. The findings revealed more than 20 active endeavours in the form of software and policy implemented by MINESEC to foster the digitalisation. Major pain points were: high computer-student ratio, absence of electric power in schools in rural areas, poor digital skills of teachers, poor management of ICT in education projects, absence of a well-defined digitalisation strategy, poor coordination, risk of increasing the digital divide, non-inclusion of learners with disabilities and vulnerable groups, difficulties in tracking the progress of digitalisation efforts, and data silos. These pain points were classified into five categories: digital infrastructure, people, governance, digital equity and inclusion, and data culture. These five categories represent the factors that can influence successful and sustainable digitalisation. As recommendations, we proposed to equip students and teachers with digital devices, create policies to encourage the provision of ICT in education infrastructure in schools, develop a competency framework for teachers that is accompanied by self-paced digital resources, create policies that can help curb mismanagement, create an ICT in education masterplan and a steering committee placed under an authority such as the Prime Minister or Presidency to coordinate the integration of ICT in education and ensure digital equity, and develop an automated EMIS and accompanying policies for data standards and management.

Keywords: Digitalisation, Digitalisation of education, Policy, EMIS, Secondary Education.

Resumé

La digitalisation est un mot à la mode depuis l'année académique 2021-2022 au sein du ministère de l'enseignement secondaire. L'arrivée de la pandémie de COVID-19 et la fermeture des écoles qui s'en est suivie ont été un signal fort de la nécessité d'accélérer l'intégration des TIC à l'éducation. Mais un tel objectif exige une infrastructure appropriée, un développement professionnel intensif, une planification et une coordination détaillées, ainsi que l'application des meilleures pratiques. Si un plan comportant des éléments visant à promouvoir les meilleures pratiques et à décourager les mauvaises pratiques n'est pas établi, la digitalisation de l'enseignement secondaire ne sera qu'un vœu pieux. Le but de cette étude est d'identifier les efforts de digitalisation mis en œuvre dans le MINESEC et les facteurs qui influencent une digitalisation réussie et durable dans l'éducation. Nous avions donc comme objectifs de: fournir une liste complète des efforts de digitalisation institués par le MINESEC; identifier les points de douleur; et recommander des moyens d'atténuer ces points de douleur. Pour atteindre ces objectifs, une étude qualitative a été réalisée à l'aide d'un modèle de recherche par étude de cas. Les données ont été collectées par l'observation, l'étude de rapports officiels, de documents politiques, d'analyses documentaires et d'entretiens. L'échantillon pour l'entretien a été choisi en fonction de son adéquation à l'objectif. L'analyse du contenu et l'analyse narrative ont été utilisées pour obtenir les résultats. Les résultats ont révélé plus de 20 efforts actifs sous la forme de logiciels et de politiques mis en œuvre par MINESEC pour favoriser la digitalisation. Les principaux problèmes sont les suivants : ratio ordinateur/élève élevé, absence d'électricité dans les écoles des zones rurales, faibles compétences numériques des enseignants, mauvaise gestion des projets TIC dans l'éducation, absence de stratégie de digitalisation, mauvaise coordination, risque d'aggravation de la fracture numérique, non-inclusion des apprenants handicapés et des groupes vulnérables, difficultés à mesurer les progrès des projets de digitalisation, et cloisonnement des données. Ces problèmes ont été classés en cinq catégories: l'infrastructure numérique, les personnes, la gouvernance, l'équité et l'inclusion numériques, et la culture des données. Ces cinq catégories représentent les facteurs qui peuvent influencer une digitalisation réussie et durable. En guise de recommandations, nous avons proposé d'équiper les élèves et les enseignants d'ordinateurs, de créer des politiques visant à encourager la mise en place d'infrastructures TIC dans l'éducation, de développer un cadre de compétences pour les enseignants qui est accompagné de ressources numériques en auto-formation, de créer des politiques qui peuvent aider à réduire la mauvaise gestion, de créer un plan directeur TIC dans l'éducation et un comité de pilotage placé sous une autorité telle que le Premier ministre ou la présidence pour coordonner l'intégration des TIC dans l'éducation et assurer l'équité numérique, et de développer un SIGE automatisé et des politiques d'accompagnement pour les normes et la gestion des données.

Mots-clés: Digitalisation, Digitalisation de l'éducation, Politique, SIGE, Enseignement secondaire.

CHAPTER 1: INTRODUCTION

The purpose of this study is to provide a review of the different guidelines, service notes, laws, decrees, or actions taken to integrate ICT in secondary education in Cameroon, explore the positive and negative effects of digitalisation and propose policies or actions that can help curb the negative effects.

Education is an indispensable tool in the construction of a viable and sustainable society (Ngwa & Mekolle, 2020). Since independence, the Cameroonian government has adopted different educational decrees and laws that have guided educational processes over the years. The most popular of these laws is Law No. 98/004 of April 14, 1998. The second point of Section 23 of this law gives the possibility for teaching to be done with the help of a distance education system, and Section 25 prescribes that teaching methods should be adapted to technological evolutions. In the year 2001, measures were taken to adapt the educational system to technological innovations. One of the first actions taken was to prepare the ground for computer science to become a subject in secondary education (Josue, 2007; Tchamabe, 2013; Nsolly & Charlotte, 2016; Haji et al., 2017). That same year, the president of the Republic, His Excellency Paul Biya, signed a decree equipping schools in Cameroon with multimedia resource centres (Josue, 2007; Lycée Joss Douala, 2013; Tchamabe, 2013; Nsolly & Charlotte, 2016; Haji et al., 2017).

Other endeavours, such as digitalising the registration processes during examinations, the payment of fees using ICT tools, the development of a web application to manage human resources, the development of a school map application, and the development of a website for MINESEC, just to name a few, have been instructed and implemented. The most recent endeavour to respond to the COVID-19 pandemic is the creation of an electronic platform where video lessons are uploaded and learners are expected to complete their study hours by watching the lessons on this platform, as well as the creation of a helpline for guidance and counselling. The coordination of these disparate and separate endeavours and the policies to support and sustain these efforts are still cloudy. If a plan with elements to promote best practices and deter poor practices is not established, then the digitalisation of secondary education will be a pie in the sky. The intent of this study is to provide information on the different endeavours to digitalise secondary education, identify major pain points in some key endeavours, and provide recommendations on how to deal with these pain points and foster a sustainable digitalisation of secondary education in Cameroon.

Background of the study

We will examine the background from four angles: historical, contextual, conceptual, and theoretical.

Historical background

Policies for the integration of information technology in Cameroon have been in place since 1966. The first information technology policy in Cameroon was Decree No. 66-DF-107 of 11-03-66, which merged the data processing department of the Ministry of Economic Affairs and Planning with the office of the President of the Republic and established a commission for the study and coordination of data processing and accounting equipment (University of Pennsylvania - African Studies Centre, 2003; Atenga, 2012).

The next policy was Decree No. 67-DF-262 of 12-06-67 governing the organisation and operation of the Central Data Processing Department (CENADI, 2020; University of Pennsylvania African Studies Centre, 2003; Atenga 2012). In 1969, Decree No. 69-DF-365 of September 13, 1969, amended Decree No. 66-DF-107 of March 11, 1966, to establish a Study and Coordinating Commission for Data Processing and Accounting Equipment. The next year, Decree No. 64-CAB-PR of 13-05-70 established the Sub-Commission responsible for the monitoring of the mechanisation of public institutions and parastatals (CENADI, 2020; University of Pennsylvania - African Studies Centre, 2003; Atenga, 2012). In 1976, Decree No. 76-258 of 02-07-76 created the Federal Department of Information Technology (DCIT). A few years later, Decree No. 84-1104 of August 25, 1984, established and organised the Ministry of Information Technology and public contracts. In this 1984 decree, DCIT became DIT. Three years later, Decree No. 88-1087 of 12-08-88 created the National Centre for Information Technology Development (CENADI) to replace the DIT. Decree No. 88-1087 of 12-08-88 was then amended by Decree No. 93-133 of 10-05-93 (CENADI, 2020; University of Pennsylvania - African Studies Centre, 2003; Atenga, 2012).

The digitalisation of the Cameroonian economy continued with the creation of the Telecommunications Regulation Board (TRB) to regulate telecommunications in 1998 by Decree No. 98/197 of September 8, 1998, which was then amended by Decree No. 2012/203 of April 20, 2012. Another major policy was Circular No. 007/CAB/PM of August 23rd, 2000, relating to the establishment and use of government websites. Then in 2005, Decree No. 2005/124 of April 15, 2005, organising the Ministry of Post and Telecommunications, which was amended by Decree No. 2012/512 of November 12, 2012, was another policy. The National

Agency for Information and Communication Technology was created on April 8th, 2002, by Decree No. 2002/092 of April 8, 2002, which was later reorganised in Decree No. 2012/180 of April 10th, 2012. There were other policies to regulate various activities linked with telecommunication and promote technology and digitalisation like the creation of SIGIPES, the Memorandum of Understanding with the Korean government with the e-government project, the e-post project, the creation of a central African backbone, and more. The upcoming COVID-19 pandemic accelerated the digitalisation of services in Cameroon with projects such as PATNuC ('Projet d'accélération de la transformation numérique au Cameroun'), with secondary education being one of the major actors actively supporting digitalisation.

The digital transformation of the Cameroonian education sector started more than two decades ago. The main activities performed during that period were the purchase of computing equipment for the different ministries and the establishment of websites under the ". gov.cm" domain name prescribed by the Prime Minister in Circular No. 007/CAB/PM of August 23, 2000. In 2001, the President of the Republic, His Excellency Paul Biya, in his speech to the youth on the 10th of February, emphasised the need to master ICTs and his desire to see schools join this dynamic. He further supported this statement by declaring that imported computers and accessories will be duty-free for schools. Since then, a lot of endeavours have been launched in the different ministries in charge of education.

To act on the statement of the president in February 2001, the Ministry of National Education that same year set up the inspectorate in charge of computer science. In 2003, syllabi for computing studies in secondary education were developed, and through a decree by the Ministry of National Education, computing education was made a compulsory subject beginning in September 2003 (Fouda et al., 2013 as cited in Nsolly & Charlotte, 2016).

Apart from purchasing computing equipment, establishing websites, and setting up the inspectorate in charge of computer science, another major programme aimed at digitalising the Secondary Education is the equipping of public schools with multimedia resource centres (MRCs). This project was launched in 2001, and in November of the same year, the President of the Republic, His Excellency Paul Biya, inaugurated two MRCs in two schools in Yaounde (the Government Bilingual High School Yaounde and "Lycée Général Leclerc"). The following year, three other MRCs were installed in Douala and Garoua (Lycée Joss Douala, 2013). By 2007, 17 multimedia resource centres were in Cameroon (Josue, 2007, Lycée Joss, 2013). As of December 2021, there are 92 MRCs in Cameroon (IP-INFO, 2021b).

In Decree No. 2005/139 of April 25, 2005, which was later amended in Decree No. 2012/267 of June 11, 2012, there is the inclusion of an IT unit, which among its many responsibilities is also in charge of the availability, security, and integrity of computing systems and the promotion of information and communication technology in the Ministry of Secondary Education. In this same decree, the Human Resource Department has a unit in charge of the SIGIPES project, which is focused on the maintenance of computer systems linked to payroll. In the 2005 decree, there is the creation of CAAP ("Cellule D'Appui à l'Action Pedagogique" which is translated as Teachers' Resource Unit in English) as a component of the Inspectorate General of Education. The Teachers' Resource Unit in the 2005 decree did not have an explicit role in the integration of ICTs in the teaching-learning process. The revision of the decree in 2012 made it responsible for the production and validation of digital pedagogic resources.

Other digitalisations endeavours have been performed in the Ministry of Secondary Education, such as the development of a web application for the human resource department (https://minesecdrh.cm), the creation of an information technology series in the French subsystem in Order No. 25/11/MINESEC/CAB of the 13th of January 2011, the creation of computing systems to manage student registration during exams, the creation of computing systems to manage student results, the payment of school fees and examination fees through electronic means, and more.

The outbreak of the COVID-19 pandemic that led to the closing of schools was a clarion call on the necessity to push the digitalisation of secondary education to another level. The Ministry of Secondary Education, under the leadership of Professor Nalova Lyonga, picked up this challenge and other digitalisation endeavours such as the Distance Education Programme, which has led to the creation of a Distance Education Centre, a web application that can be accessed through https://minesec-distancelearning.cm/, a YouTube channel that can be accessed through https://www.youtube.com/user/minesecdistancelearning1724, and an e-counselling service. The beginning of the academic year 2022-2023 started with the Minister of Secondary Education launching the e-counselling helpline as part of the Distance Education Programme and placing the academic year 2022-2023 under the theme: "Digitalisation of teaching: an effective and efficient determining factor for the provision of training at the Ministry of Secondary Education". MINESEC has also signed partnership agreements with organisations such as iPLANS and strengthened its collaboration with international organisations such as UNESCO, Commonwealth, and other ministries such as MINPOSTEL.

Even though the digitalisation of secondary education has been underway for more than two decades, there is no explicit policy document or masterplan dedicated to the digitalisation of education or secondary education. Although the National Agency for Information and Communication Technologies (NAICT) produced a policy document for the development of ICTs in Cameroon and gave some guidelines for the education sector, it is not enough to call it a policy or masterplan for ICT integration when compared to prescriptions provided by UNESCO in their document "Guidelines for ICT in education policies and masterplans" or policy documents for digitalisation produced by other countries.

Contextual background

The Cameroonian government has, through many endeavours, tried to ensure the growth of technology in all the activities in its economy. One way the government has tried to do this is through the creation and restructuring of organisations such as NAICT, TRB, and CENADI.

CENADI is the oldest organisation currently running that oversaw the development of information and communication technology in Cameroon. According to Atenga (2012), the computerisation of the Cameroonian public administration was the task attributed to the Department of Information Technology (DIT) which became CENADI. Atenga (2012), affirms that upon creation of CENADI, it was responsible for the following:

- implementing government policy in information and communication technology;
- advising the government and public and semi-public administrations, local authorities, etc. on information and communication technologies (ICTs);
- drawing up of masterplans;
- carrying out IT audits;
- developing applications;
- providing extranet and intranet application services;
- handling back-end and batch production;
- hosting applications and backing up data of IT systems.

Atenga (2012) explains that the mission of CENADI was changed due to constraints provided by the International Monetary Fund (IMF) to the Cameroonian Government to reduce the State's cost of living, which involved a greater control over the number of civil servants. CENADI's missions were redefined to enable it to fulfil this condition effectively. It is responsible for the delicate task of taking a census of civil servants as part of Operation Antelope and issuing their pay slips. At a time when the Cameroonian economy was in disarray (Courade, 2000, as cited

in Atenga, 2012), the focus was no longer on IT research or computerising government departments but on controlling expenditure. From its headquarters in Yaoundé, the capital, to its various branches in Bafoussam, Douala, and Garoua, the three other main towns, CENADI acts as a data processing centre, i.e., a platform for hosting and processing other types of IT applications: Pagode, Trinité, and Campac. This confinement of CENADI's missions was made official by Decree No. 93-133 of 10-05-93, which attached it to the Ministry of Finance and Budget, one of Cameroon's most apoplectic and complex ministerial departments. With no real administrative or financial autonomy, CENADI was, from the outset, merely a consultative body whose technical opinions were more or less taken into account by the government (Atenga, 2012).

The Telecommunications Regulation Board was created in 1998. Republic of Cameroon (2012b) presents in Decree No. 2012/203, April 20, 2012, the missions of the TRB. These missions are the following:

- ensure the implementation of the legal and regulatory texts in telecommunications and information and communications technologies;
- ensure that access to open networks by the public is carried out in objective, transparent, and non-discriminatory conditions;
- ensure safe and legal competition in the telecommunications sector and in the information and communications technology sector;
- sanction any breach of obligations by operators as well as non-competitive practices;
- establish the principles regulating the pricing of supplied services;
- provide information on the acquisition of licenses and prepare decisions related to a given request;
- issue receipts for declarations;
- define the conditions and obligations of interconnection and the sharing of infrastructure;
- advise on all legislative and regulatory texts relating to electronic communications;
- ensure allocation and control of the frequency spectrum;
- prepare the call to tender files for concessions and licenses;
- develop and manage the numbering plan;
- submit any proposal and recommendation that could develop and modernise the telecommunications and information communications technology sectors to the government;

- allocate addressing resources;
- examine applications for homologation in supplying equipment and devices and prepare the relevant decisions;
- issue accreditations;
- carry out any other mission of general interest that the government may entrust to it in the Telecommunications and Information and Communication Technologies sector;
- guarantee consumer protection.

The NAICT was created in 2002. The current statutory tasks of NAICT are defined in Section I and Section II of Chapter II of Decree No. 2012/180, April 10, 2012, on the organisation and functioning of the National Agency for Information and Communication Technologies. The agency has as its mission to provide on behalf of the State the following:

- promotion and monitoring of public policy in the sector of information and communication technology (ICT);
- regulating, controlling, and monitoring activities related to the security of electronic communication networks and information systems, as well as electronic certification, in collaboration with the Telecommunications Regulatory Board.

According to the Republic of Cameroon (2012a), besides NAICT's missions of promotion and follow-up of the action of public authorities in information and communication technologies, the Agency is particularly responsible for the following:

- develop and monitor the implementation of the national strategy for ICT development;
- identify the common needs of public services in software and computer equipment;
- ensure the harmonisation of technical standards and propose technical repositories to promote interoperability between information systems;
- provide its expertise to governments in designing and developing their technical objects;
- coordinate the implementation and monitoring of websites, intranets, and extranets of the State and public bodies;
- contribute to technical training to train universities, colleges, high schools, institutions of higher training, and primary schools;
- participate in the actions of training State personnel in the field of ICT by issuing recommendations on the content of technical training and programmes for professional examinations, contests, and competitions.

- develop ties of technical cooperation with international public or private bodies active in the field provided by the legislative force. In this perspective, it handles the registration of the ".cm" domain name.
- implement mechanisms to resolve disputes, on the one hand, between ICT operators and, secondly, between operators and users, for problems specifically related to the content and quality of services (scamming, phishing, hacking);
- ensure the use of ICT with respect to ethics, as well as the protection of intellectual property, privacy, consumers, and morality;
- develop policy and procedures for the registration of ".cm" domain names, hosting, administrative root servers, and naming for the approval of the ".cm" domain.
- plan, assign, and control internet addresses (IP) in Cameroon;
- put in place mechanisms to ensure internet security at the national level;
- regulate information and communication technologies and the internet.

The missions of NAICT show that it is currently the competent organisation in charge of ensuring the digitalisation of processes in Cameroon in partnership with TRB, which are all supervised by the MINPOSTEL, as expressed in Decree No. 2018/190 of March 2nd, 2018, which aimed at modifying and completing Decree No. 2011/408 of December 9th, 2011. This implies that the actors involved in digitalising secondary education must work hand in hand with the Ministry of Post and Telecommunications.

The Cameroonian Government, in the Growth and Employment Strategy Paper, had goals to improve access and equity, effectiveness and quality, partnership, management, and governance (Republic of Cameroon, 2010). The promotion of ICT in the Ministry of Secondary Education in this paper had four main actions:

- progressive construction of Multimedia Centres in high schools;
- extension of the computer equipment of central and deconcentrated services;
- introduction of training modules on ICTs (pre-service and in-service) for teachers;
- elaboration of training modules for students.

These actions were to be measured with the help of the following indicators:

- number of high schools with a Multimedia Resources Centre;
- number of central and deconcentrated services equipped;
- training modules for teachers elaborated;
- training modules for students elaborated;

- gender mainstreaming in curricula (Republic of Cameroon, 2010).

The National Development Strategy 2020-2030 (NDS30) continues in the same footing and is based on lessons learned in the implementation of the Growth and Employment Strategy Paper (GESP) and considers digital technology as a key element to transform the Cameroonian economy (Republic of Cameroon, 2020). Statistics from NDS30 show that security issues in some regions of Cameroon, notably the Northwest and Southwest, in 2017 led to a drop in the admission rate to the first year of secondary education from 69.7% in 2016 to 55.4% in 2017, which was already an indication of the necessity of accelerating the digitalisation of education. The advent of the COVID-19 pandemic was a clarion call showing the necessity to accelerate the digitalisation of education.

In NDS30, the Cameroonian Government aims to considerably reduce the digital divide, particularly by continuing to expand the optical fibre network, building two data centres, and implementing an electronic governance system (E-Government). Their objectives are thus the following:

- reconfigure the national digital ecosystem, particularly by restructuring the sector through the creation of a digital infrastructure heritage company;
- build the consequent digital infrastructure;
- secure networks globally;
- set up digital and technology parks for developing the production of digital content;
- increase and diversify digital uses and services;
- develop the manufacturing and assembly of digital parts and appliances.

Amongst all this, the first step should be the installation of proper ICT in education infrastructure in all parts of the country to ensure accessibility and equity as prescribed in GESP. A well-developed and stable ICT infrastructure in education nationwide is generally the first phase of any policy or masterplan for the digitalisation of an educational system or sector. Such an infrastructure will foster communication and the flow of information between stakeholders in central and deconcentrated services and help in teaching, learning, assessment, and administration in schools. Even though such infrastructure will bring advantages, it can also lead to issues such as the distraction of staff and students and the uncontrolled spread of information. Policies to define how such infrastructure will be used, procured, minimum characteristics, which information will be accessed, and others are necessary to foster the advantages and curb issues related to the use of such an infrastructure.

Currently, in MINESEC, there is no organisation, centre, or unit that is focused only on managing digitalisation. Also, the ICT infrastructure for education is absent in most secondary schools. Multimedia resource centres, which are still not up to the desired standard of ICT in education infrastructure, are currently installed in just 92 secondary schools in Cameroon out of more than 2500 government secondary schools. There are a lot of areas without power; for instance, in the Ndian division, only the main town of Mundemba has electrical power provided by ENEO. Most regions in Cameroon do not have stable internet connections. Thus, infrastructure is still an issue that needs serious attention from the government.

Normally, there should be a policy or masterplan on how in-service and pre-service personnel will be equipped with technology and techno-pedagogic competencies. Such a policy should even move up to the level of citizens so that every citizen will have an acceptable level of skills when it concerns digital technology. If every staff member or teacher has an average skill level in the manipulation of digital technology and techno-pedagogic skills, then the integration of technology into the teaching and learning process, administration, or evaluation will be seamless since the component of resisting change due to a lack of skills will be absent. Also, digitalisation should lead to policies that incentivize teachers or personnel who are effectively using these technologies.

Unfortunately, the Ministry of Secondary Education still has a lot of personnel whose competency in computing is still very low. Even in the Higher Teachers Training Colleges, there are departments where learners move through their training cycle without seeing or touching the computer or without a course to develop their competencies in techno-pedagogy. Continuous training of teachers is planned just once a year during pedagogic days, and not all teachers attend such training. Also, the multitude of materials to cover, the rapid nature of such a training, and the lack of follow-up after the training make it inefficient. Moreover, the Cameroonian educational system gives room for the recruitment of part-time teachers, who are generally not trained and do not have an authorisation to teach. Such teachers are difficult to manage or deal with since they are not directly linked to the government. Thus, human resource development programmes to accommodate digitalisation should be inclusive enough to give room for such teachers to be trained.

In the national policy for the development of ICT in Cameroon produced by NAICT in 2007, putting in place a computerised educational management information system was one of the major goals. The development of an EMIS should lead to policies that will help protect learners' information, control sharing of information, ensure data integrity, and more. The educational

management information system currently in use is not automated. Currently, there is an information system to manage human resources, a different information system to manage public exams for the different examination boards, and different schools that have automated their information systems use different software providers. Even though the Ministry of Secondary Education is automating a lot of its processes, there is little or no coordination and integration between these different technologies, thus leading to issues of integration, coordination, interoperability, and data integrity.

The provision of distance education requires a policy or masterplan on how to reduce the digital divide and inequalities. Also, a masterplan to overcome barriers related to accessibility is necessary mostly for rural areas. Moreover, harnessing the benefits of distance education requires changes in the way teaching is done and organised. Policies or masterplans to guide and support teachers are indispensable. Unfortunately, there is no explicit policy or masterplan for distance education in the Ministry of Secondary Education in Cameroon. Currently, the Ministry of Secondary Education runs a Distance Education Programme that is made up of a distance education centre, an online platform to access content, a YouTube channel, and an e-counselling helpline. The online platform has more than 8,000 online resources, which constitute just a small percentage of the number of resources needed to cover the material in the Ministry of Secondary Education. Thus, the necessity to produce more materials Also, some of the content produced does not respect best practises for producing multimedia content. Moreover, there is no robust way of measuring the effective use of the platform or getting feedback from learners. There is also no organised way of keeping traces of learners' difficulty when they connect through the helpline. Such data can help the Ministry of Secondary Education know the main issues faced by learners and parents. It can also help predict learners' behaviour and thus reduce cases of violence in the school milieu.

The above scenarios show there are a lot of digitalisation efforts being conducted in the Ministry of Secondary Education. This raises questions about the integration, interoperability, and coordination of all these efforts and of compliance to support and sustain digitalisation of secondary education. There is thus a need for the Ministry of Secondary Education to develop policies and masterplans to support and sustain the digital transformation of secondary education.

Conceptual background

A policy refers to a set of ideas or a plan of what to do in a particular situation that has been officially endorsed by a group of people, an organisation, or the government (Ngwa & Mekolle, 2020). Birkland (2016) defines policy as a government statement at whatever level or form about what it intends to do about a public problem. It contains a set of principles purposefully put together to guide actions, decisions, and the achievement of rational outcomes. UNESCO (2013) defines policy as a broad statement that sets out the government's main goals and priorities. It is in line with the country's constitution and can be sector-wide (e.g., education sector policy) or specific to a sub-sector (e.g., primary education) or to a certain issue (e.g., low enrolment rates). Tambo (2003) posits that policies are authoritative guiding principles from the government to institutions that spell out the government's agenda and how this agenda is to be achieved.

In this study the term policy and public policy will be used interchangeable even though public policy refers to policies created by government entities or their representatives. Public policy goes beyond laws and regulations enacted by legislative statesmen and implemented by public administrators. It also includes government's plans, programmes, instructions, decisions and other symbolic systems. Even though a government programme can be a public policy, not all public policies are programmes (Ngwa & Mekolle, 2020). Presidential decrees and laws, ministerial orders, circulars, instructions, and laws adopted by parliaments are examples of public policies. Policies that regulate activities in the educational sector are called educational policies.

Anja (2001) as cited in Ngwa and Mekolle (2020), argue that educational policy, also known as educational legislation, is the branch of education that deals with legislation and rules set by government to regulate education for conformity and regularity. These legal instruments and rules, as stated by Anja, are meant for directing, supervising, and controlling the educational enterprise in a given country, State, or region.

In this study, educational policy will refer to any law, decree, order, circular, instruction, statement, service note, programme, or project created by government entities or their representatives to direct, supervise, or regulate the education sector, a specific education sub-sector, or an educational issue. This definition has been adopted because it gives a wide range to what can be considered policy, expresses the fact that a policy must not be nationwide, and

does not reduce educational policy to Law No. 98/004 of April 14, 1998, which some authors do not consider an educational policy.

An educational policy will be characterised by the following:

- formal and authoritative orders (laws, decrees, orders, circulars, instructions);
- statements made by government authorities;
- programmes or projects;
- documents that address an issue.

According to Nordlo (2023), digitalisation is the utilisation of digital technology in order to streamline and change processes while digital transformation is when an organisation carries out digitalisation of its entire operations. Digital transformation may involve the gradual digitalisation of internal processes until the company has fully completed the digitalisation process. The European Commission defines digital transformation as "a fusion of advanced technologies and the integration of physical and digital systems, the predominance of innovative business models and new processes, and the creation of smart products and services". There is no exact template outlining how digital transformation should be carried out and how long it takes, but a strategic, goal-oriented approach is a common feature of every process (Nordlo, 2023). Velden (2018) posits that digitalisation covers the use of digital information and communication technologies, including the interconnectivity and networking of these technologies. Digitalisation differs from digitisation; the latter refers to the process of making something digital. Digitalisation is then about the processing and networking of what has become digital data. Tilson, Lyytinen, & Sørensen (2010) as cited in Autio (2017), defines digitalisation as "the sociotechnical process of applying digitising techniques to broader social and institutional contexts that render digital technologies infrastructural". Digitalisation is the application of digital technologies and infrastructures in business, economy, and society (Autio, 2017).

Digitalisation is thus a process that is independent of the sector or area of application. The digitalisation of education has had different appellations in different eras, contexts, communities, and organisations. In 2001 in Cameroon, it was called ICT integration; since 2020 in MINESEC, it is called the digitalisation of education; and UNESCO (2022) calls it ICT in education. In this study, the words digitalisation of education, ICT integration in education, ICT in education, technology in education, and digital transformation of education will be used interchangeably.

‘ICT in education’ refers to the intersection of ICT and education that pertains to multiple perspectives, including the following: the use of ICT as a **provision medium** by providers of educational programmes to enable or expand access to learning opportunities; the use of ICT as **pedagogical tools** by teachers and learners to improve the relevance and quality of teaching and learning processes; and the development of **ICT competencies** or digital skills needed for living, learning, and working in our increasingly technology-rich world (Miao & Al, 2022). Arisoy (2022) and SIEMENS (2022) view digitalisation in education as the use of digital technology to teach students. Saiful and Nusrat (2018) define digital technology for education as any process where the teacher or learner uses digital equipment such as a personal computer, a laptop, tablet, MP3 player, or console to access digital tools such as learning platforms and virtual learning environments (VLEs) to improve their knowledge and skills. Learning with digital technology comprises ICT products such as teleconferencing, email, audio, television lessons, radio broadcasts, interactive voice response systems, etc. Ministry of Education Montenegro (2021) posits that digitalisation of the education system involves not only the introduction of digital technologies into the teaching process but also the digitalisation of all the processes in the education system, the development of electronic services for students, teachers, and parents, and data exchange with other institutions with the aim of modernisation and more efficient work when it comes to the administrative processes in all departments. At the same time, during the development of the digitalisation of teaching and the raising of the quality of education, special attention should be paid to children who do not have the conditions to use technology (the poor population), children with special educational needs, as well as talented students.

The definition provided by Miao et al. (2022) does not explicitly include aspects related to administration, monitoring and evaluation. Adding clearly the perspective of activities related to administration, monitoring and evaluation we can update the definition of Miao et al. (2022) by claiming that digitalisation of education pertains to the following perspectives: the use of ICT as a **provision medium** by providers of educational programmes to enable or expand access to learning opportunities; the use of ICT as **pedagogical tools** by teachers and learners to improve the relevance and quality of teaching and learning processes; the development of **ICT competencies** or digital skills needed for living, learning, and working; and the use of ICT to **enhance administrative, monitoring and evaluation** processes and activities in education. In this study we adopt the definition of McCarthy et al. (2023) that define digital transformation as a realignment of education models utilising digital technology to engage students, teachers,

parents, and leaders more effectively at every point in the students' schooling journey with new student information systems, personalised experiences and data analytics.

The following actions will be considered instances of digitalisation in education:

- provision of ICT in education infrastructure;
- human resource development to accommodate digitalisation;
- presence of a computerised EMIS;
- presence of distance education.

Theoretical background

Digitalising education is a process that deals with people and culture and thus involves social change. Social change is the process whereby individuals and communities adjust or abandon customs and associated leading ideas, values, and purposes to act differently in response to random or systemic factors (Asian Development Bank, 2017). Change theories help to understand and navigate the complexity of social change. Moreover, digitalising education in Cameroon has mostly gone through the launching and implementation of programs. A program is defined as related projects, subsidiary programs, and program activities managed in a coordinated manner to obtain benefits not available from managing them individually (PMI, 2017). This study will thus be supported by change theory, specifically Kurt Lewin's change model of unfreezing, changing, and refreezing and a program management model specifically the model proposed by the Project Management Institute (PMI) in their book standards for program management.

Lewin believed that any level of behaviour is maintained in a condition of quasi-stationary equilibrium by a force field comprising a balance of forces pushing for and resisting change. This level of behaviour can be changed by either adding forces for change in the desired direction or by diminishing the opposing or resisting forces. Lewin preferred the method of achieving change that is based on reducing the restraining forces in preference to increasing the forces pushing for change (Schein, 1995). He argued that approaches involving the removal of restraining forces within the individual, group, or organisation are likely to increase commitment and result in a more permanent change than approaches involving the application of outside pressure for change. Lewin's theory of change is a three-step process: unfreezing, changing, and freezing. Managing change thus involves unlocking the existing level of behaviour, moving to a new level, and then refreezing the behaviour at this new level (Schein, 1995).

Unfreezing is the stage where the balance between driving and restraining forces is destabilised. Many authors in literature have provided different ways of unfreezing. Kotter (1995) argues that the current state of equilibrium can be destabilised by alerting organisational members to the need for change. Creating a vision of a more desirable future state and providing information that creates a sense of urgency. Schein (1995) proposes that providing disconfirming information that arouses survival anxiety can motivate change.

Lewin's second stage of changing or moving is where the balance of driving and restraining forces is modified to shift the equilibrium to a new level. Although these forces can assume many forms, they tend to manifest in terms of behaviours that affect performance (Ford & Greer, 2006). Consequently, movement tends to be achieved by adjusting attitudes and beliefs, and modifying the processes, systems, and structures that shape behaviour (John Hayes, 2014).

Refreezing involves reinforcing new behaviours to maintain new levels of performance and avoid regression. Feedback that signals the effectiveness and consistency of new behaviours and incentives that reward new levels of performance can help enshrine new practises (Schein 1995, Hayes, 2014).

This theory of change has been adopted for this study because the digitalisation of secondary education is a long-term process that involves a change of methods and perspectives by a variety of stakeholders (teachers, students, parents, administrators, and policymakers). Moreover, this theory provides a framework to manage change and obtain long-lasting and sustainable outcomes.

Program management refers to the application of knowledge, skills, and principles to a program to achieve the program objectives and to obtain benefits and control not available by managing program components individually. Program management involves the alignment of program components to ensure that program goals are achieved, and program benefits are optimally delivered (PMI, 2017).

Programs deliver their intended benefits primarily through component projects and subsidiary programs that are pursued to produce outputs and outcomes. The components of a program are related through their pursuit of complementary goals that each contribute to the delivery of benefits. Component projects or programs that do not advance common or complementary goals; or that do not jointly contribute to the delivery of common benefits; or that are related only by common sources of support, technology, or stakeholders are often better managed as portfolios rather than as programs.

According to Levin and Green (2014), the PMI recognised the importance of program management in 2006 and issued a model or standard to program management. This standard or model describes best practices in program management and contains a common set of terms to best communicate globally among the various program stakeholders. These best practices are of enormous value, as they show the importance of key documents to initiate a program, plan it, execute and monitor and control it, and close it.

Program management is performed by a program manager. The program manager ensures the effective alignment, integration, and control of a program's projects, subsidiary programs, and other program activities by actions taken in five interrelated and interdependent Program Management Performance Domains: Program Strategy Alignment, Program Benefits Management, Program Stakeholder Engagement, Program Governance, and Program Life Cycle Management. Program Management Performance Domains are complementary groupings of related areas of activity or function that uniquely characterize and differentiate the activities found in one performance domain from the others within the full scope of program management work. Through these Program Management Performance Domains, the program manager oversees and analyses component interdependencies to determine the optimal approach for managing program components (PMI, 2017).

According to PMI (2017), actions related to these interdependencies may include the following: defining how the outputs and outcomes of a program's components are expected to contribute to the program's delivery of its intended benefits and support the organisation's strategy; monitoring benefits realisation of program components to ensure they remain strategically aligned to the organisation's goals; ensuring that the outputs and outcomes of a program's components are effectively communicated and considered so that a program can effectively optimise the pursuit of its intended benefits and provide value; leading and coordinating program activities (for example, financing and procurement) across all program components, work, or phases; communicating with and reporting to stakeholders to provide an integrated perspective on all activities being pursued within the program; proactively assess and respond to risks spanning multiple components of the program. aligning program efforts with the organisational strategy and the program's business case; resolving scope, cost, schedule, resource, quality, and risk issues within a shared governance structure; tailoring program management activities, processes, and interfaces to effectively address cultural, socioeconomic, political, and environmental differences in programs.

Program managers apply program management principles to ensure that programs and their components are appropriately planned, controlled, and completed, and that program benefits are appropriately delivered and sustained (PMI, 2017).

This model was adopted for this study because digitalisation of an organisation such as secondary education is a complex and long-term program requires a systematic process for planning, implementing, and monitoring and control so as to obtain long-lasting and sustainable outcomes. Levin and Green (2014) affirm that success in programs requires appropriately complete plans, well-run meetings with meaningful agendas, accurate record keeping, and general adherence to global best practices. Standards of program management provide these best practices. This model was also chosen because it explicitly recognises the importance of managing change in the process of program management. Moreover, it will help to identify or corroborate pain points in the current management of programs for digitalising secondary education in Cameroon and recommend methods of dealing with the pain points.

Statement of the problem

There is no gainsaying that the world has gone digital and there is need to adapt to and migrate most activities onto digital platforms. Since the year 2000, the Ministry of Secondary Education has been trying to integrate ICT in educational processes via different endeavours such as the creation of multimedia resource centres, the electronic registration of candidates in official exams, the electronic payment of school fees and examination fares, applications to manage in-service personnel, application to deploy pre-service personnel, and more. The onset of the Covid 19 with its subsequent lockdowns was a clarion call for the immediate and absolute acceleration of the digitalisation process in Secondary Education. The Ministry of Secondary Education under the leadership of Professor Nalova Lyonga embraced the challenge and instituted the Distance Education programme whereby, unlike the traditional face-to-face or in-person teaching and learning process, lessons are prepared and stored in formats and platforms that can be accessed by students across the nation. The Minister also created an e-counselling helpline and is working with other Ministries such as MINPOSTEL and international partners such as UNESCO, Commonwealth to ensure the effective digitalisation of Secondary Education. Digitalisation of a sector such as education comes with a lot of changes and thus demands a consistent plan to ensure its effective implementation, monitoring, and sustainability. Also, MINESEC is using a multitude of technologies, and the use of separate technologies to solve given problems can lead to issues of data sharing, collaboration, integration, and coordination. It is thus necessary to identify all what has been done so far in

terms of digitalising education in Cameroon, the pain points of the different endeavours and propose a way of mitigating these pain points and facilitating the coordination, monitoring and evaluation of digitalisation efforts in Secondary Education.

Purpose of the study

The aim of this study is to identify the factors that influence a successful and sustainable digitalisation of Secondary Education in Cameroon by analysing source documents and current digitalisation endeavours and interviewing educational authorities and experts with the goal of identifying pain points or issues that may evolve and proposing ways of mitigating these issues.

Objectives

The objectives of this study are the following:

- produce a comprehensive list of key digitalisation efforts instituted by MINESEC and existing policies aimed at supporting it;
- identify pain points of digitalising Secondary Education in general and of some critical digitalisation efforts implemented by the Ministry of Secondary Education;
- propose solutions to mitigate these pain points and ease the effective use, coordination, monitoring and evaluation of future digital endeavours.

Research questions

- What are the different digitalisation efforts instituted in the Ministry of Secondary Education and the policies to support them since the creation of MINESEC?
- What are the challenges linked to digital transformation and the limitations of the different digitalisation efforts implemented in the Ministry of secondary education?
- How can challenges and limitations related to the digital transformation of secondary education be mitigated?

Scope/delimitation of the study

The study concerns the Secondary Education in Cameroon even though most of the interviews conducted, data analysed will be based on the Centre region. The content will be focused on digitalisation and policies linked to digitalisation.

Significance of the study

This study will help show challenges and limitations related to the digitalisation of Secondary Education in Cameroon and propose solutions to ensure a successful and sustainable

digitalisation process. Moreover, it will add to literature since there is the absence of a unified comprehensive list of digitalisation efforts implemented in Secondary Education from its creation till date. This study will help the Ministry of Secondary Education see issues related to their digitalisation process and policies that can be derived to protect citizens, motivate teachers, achieve equity, and ensure a sustainable digitalisation process. It will also provide guidance to educational leaders in Cameroon that are implementing digital transformation. Also, future studies can reference this work to get information on digitalisation efforts conducted in MINESEC, challenges and even proposed policies that are adapted to the Cameroonian context.

Operational definition of terms

- Digitalisation of education refers to the realignment of education models utilising digital technology to engage students, teachers, parents, and leaders more effectively at every point in the students' schooling journey with new student information systems, personalised experiences and data analytics (McCarthy et al., 2023).
- Policy refers to a set of ideas or a plan of what to do in a particular situation that has been officially endorsed by a group of people, an organisation, or the government (Ngwa & Mekolle, 2020).
- Educational policy refers to any law, decree, order, circular, instruction, statement, service note, programme, or project created by government entities or their representatives to direct, supervise, or regulate the education sector, a specific education sub-sector, or an educational issue.
- ICT in education infrastructure refers to physical systems such as computers and related accessories, networking and information accessibility devices, buildings, sources of energy, security devices, and software that support the functioning of the physical systems and related goals of the educational sector implanting the infrastructure (Miao et al., 2022).
- EMIS can be defined as 'a system for the collection, integration, processing, maintenance, and dissemination of data and information to support decision-making, policy analysis and formulation, planning, monitoring, and management at all levels of an education system. It is a system of people, technology, models, methods, processes, procedures, rules, and regulations that function together to provide education leaders, decision-makers, and managers at all levels with a comprehensive, integrated set of relevant, reliable, unambiguous, and timely data and information to support them in the completion of their responsibilities' (UNESCO, 2008).

- Human resource development for digitalisation is the process by which the personnel of an organisation are helped in a continuous and planned way to: acquire or sharpen technological or techno-pedagogical capabilities required to perform various functions associated with their present or expected future roles; develop their general technological capabilities as individuals and discover and exploit their own inner potentials for their own and/or organisational development purposes; develop a culture in which teamwork and collaboration are strong and contribute to the professional well-being, motivation, and pride of personnel.
- Distance education refers to a generic term for modes of education in which the students and the teacher are separated in time and space. It includes online education (with >= 80% of the content delivered online) and blended education (with 30-79% of the content delivered online), as well as modes of education using printed material delivered by post and/or other tools for bridging the distance (Carlsen, Holmberg et al., 2016).

CHAPTER 2: LITERATURE REVIEW

Conceptual Framework

In this section, we will provide a clear and concise understanding of key concepts in this study and highlight possible relationships.

Digital Transformation of Education

Digitalisation or digital transformation is the combined effect of several digital innovations bringing about novel actors (and actor constellations), structures, practises, values, and beliefs that change, threaten, replace, or complement existing rules of the game within organisations, ecosystems, industries, or fields (Hinings et al., 2018, as cited in McCarthy 2020). The European Commission defines digital transformation as "a fusion of advanced technologies and the integration of physical and digital systems, the predominance of innovative business models and new processes, and the creation of smart products and services". According to Le Pham (2021), digital transformation involves improving the core business processes of a company to effectively fulfil customer expectations through data and technology leveraging. Verina and Titko (2019) give definitions from different authors. Digital transformation is a "process through which companies converge multiple new digital technologies, enhanced with ubiquitous connectivity, with the intention of reaching superior performance and sustained competitive advantage by transforming multiple business dimensions, including the business model, the customer experience (comprising digitally enabled products and services), and operations (comprising processes and decision-making), and simultaneously impacting people (including skills, talent, and culture) and networks (including the entire value system)." (Ismail, Khater, & Zaki, 2017, as cited in Verina & Titko, 2019). Digital transformation requires the organisation to deal better with change overall, essentially making change a core competency as the enterprise becomes customer-driven end-to-end. Such agility will ease ongoing digitalisation initiatives but should not be confused with them (Bloomberg, 2018, as cited in Verina & Titko, 2019).

According to McCarthy et al. (2023), digital transformation has taken a greater speed in businesses and other industries than in education, and they propose that education could learn from the lessons of the industry. They insist that understanding what digital transformation means in an educational context and communicating this clearly to stakeholders is a key first step for school and system leaders looking to advance their digital transformation goals.

Digitalisation of the education system involves not only the introduction of digital technologies into the teaching process but also the digitalisation of all the processes in the education system, the development of electronic services for students, teachers, and parents, and data exchange with other institutions with the aim of modernisation and more efficient work when it comes to the administrative processes in all departments. At the same time, special attention during the development of the digitalisation of teaching and the raising of the quality of education should be paid to children who do not have the conditions to use technology (the poor population), children with special educational needs, as well as talented students (MoE Montenegro 2022). Miao et al. (2022) define digitalisation of education as the intersection of ICT and education that pertains to multiple perspectives, including the following: the use of ICT as a provision medium by providers of educational programmes to enable or expand access to learning opportunities; the use of ICT as pedagogical tools by teachers and learners to improve the relevance and quality of teaching and learning processes; and the development of ICT competencies or digital skills needed for living, learning, and working in our increasingly technology-rich world. Tchombe (2009), as cited in Akumbu et al. (2021), view ICT integration in education as the process of choosing and using the right applications and tools for the preparation, presentation, and evaluation of learning. McCarthy et al. (2023) define digital transformation as a realignment of education models utilising digital technology to engage students, teachers, parents, and leaders more effectively at every point in the students' schooling journey with new student information systems, personalised experiences, and data analytics.

Advantages and potential challenges of Digitalising Education

Verina and Titko (2019) present the following as advantages of digital transformation: a boost to sustainable growth; effective knowledge collection, sharing, and use; improved efficiency and reduced cost; greater customer interaction and collaboration. Khan et al. (2019), as cited in McCarthy (2020), report that one key advantage of integrating digital technologies in education is that it can assist in overcoming contextual barriers for students' learning in rural or remote areas. UNESCO (2013) reports that Information and communication technology (ICT) have the potential to increase access to information; make learning available anytime, anywhere; and make learning more enjoyable for learners, thereby improving participation rates and learning outcomes. Use of ICT can also improve the quality of teaching, enable the creation of more relevant and stimulating learning materials, improve education management, enhance the provision of educational services and make such services more cost-effective. Le Pham (2021) claims that the digitalisation of education can help track student results, improve results with

data analytics, promote cooperative learning, encourage future-focused curricula, enhance constructive collaboration between parents and teachers, and save time. UNESCO (2021a) believes that connected technology can enrich educational processes and improve learning outcomes. More precisely, it enables anytime and anywhere learning; assists students with disabilities; gives room for innovation and inclusive avenues; provides immediate feedback and support; and can bridge formal education with informal learning. MoE Montenegro (2022) posits that the introduction of ICT into the teaching process and the learning process, carried out in accordance with predetermined goals and standards, can significantly contribute to the quality of educational work, to learning efficiency, communication, independent learning, and to a better didactic organisation of teaching. Makosa (2013) provides the following as advantages of digitalising education: great commitment from learners since lessons are more involving; equalisation of educational opportunities; increase in effectiveness; development of digital literacy; transparency of the activities of educational organisations; optimisation of the interaction between teachers and students; and the ability to build individualised educational trajectories. UNESCO (2023a) reports that the digitalisation of education has the potential to speed up progress towards Sustainable Development Goal 4, provide universal access to learning, enhance the quality and relevance of learning, strengthen inclusion, and improve education administration and governance. Manyengo (2021) argues that if digital technologies are utilised properly, they can assist with teacher workloads, especially in classrooms with large student-to-teacher ratios. Akumbu et al. (2021) posit that the digitalisation of education will permit the successful planting of the technology culture in Cameroon, ensure the attainment of SDG 4, and allow for continued teaching during disease outbreaks.

Digitalising education may lead to certain challenges. According to Mai (2022a) the main challenges of digital transformation are lack of skilled workforce, lack of data, security concerns, and budget constraints. Verina and Titko (2019) believe that one of the main barriers to digital transformation could be staff resistance. Le Pham (2021) highlights the following as possible challenges of digitalisation: reticence to change, inferior knowledge or skills, data silos, lack of instructions or strategy, and system-based compatibility. UNESCO (2021a) observes that without a change in course, technology integration in education risks heightening student isolation, exacerbating inequalities, narrowing learning experiences, and privatising education, undermining its status as a public good. Makossa (2013) posits that digitalisation can lead to the following issues: lack of socialisation opportunities and self-discipline. He also argues that the lack of technical skills and access to technology are major barriers to the

digitalisation of education. Armila (2022) argues that digitalisation of education cannot be an equalising factor if other basic inequalities such as textbooks, daily meals, transportation, infrastructure are not managed. Armila (2022) also believes that aims of democracy and empowerment in educational discourse seem, and are, ethical but if they are transformed as tools for digitised psycho-capitalism, they begin to serve other 'masters' than intended. In this tendency, technology can "commodifcate" education and invite only those with technological resources, capabilities, and aspirations. Those who call for more personal educational relationships and equality of opportunities are at a risk of becoming silenced. Manyengo (2021) reports that the main challenges of integrating technology in teaching and learning include: inadequate teacher training for digital skills development; integrating digital skills in teaching and learning; insufficient ICT infrastructure (lack of access to digital facilities and technology in schools and at home, and low internet and power connectivity in some schools and regions); lack of support from parents on the use of ICT for learning; risk of favouring a certain segment of the population, particularly those in urban areas; lack of funding for maintenance of digital infrastructure; and outdated policies and policy gaps. Tchamabe (2010), Béché (2013, 2017, 2020) as cited in Akumbu et al. (2021) report that the lukewarm culture to the pedagogic integration of ICTs in Cameroon is due to: absence of a vibrant educational technology policy (Tchamabe 2010), non-appropriation of educational technologies, Béché (2013, 2017, 2020), lack of up-to-date computer equipment or adequate multimedia rooms, and a significantly weak telecommunication environment (absence of strong and high-speed internet connection).

Factors that can promote or inhibit digitalisation of education

Le Pham (2021), Mai (2022), McCarthy et al. (2023) all agree that the industry is more advanced in the process of digitalisation than education and urge educational leaders to learn from industry experiences. According to the WEF (2021), digital transformation varies greatly between different companies, but in a nutshell, any successful strategy needs to adhere to a number of core principles:

- Follow a clearly defined vision, focused on the customers' needs and shared by the whole team.
- The C-suite needs to take the lead in ensuring that the path to that vision balances the needs of the company, its staff, its shareholders and the wider community, as well as deciding what considerations should be embedded into every business decision.
- Be backed with the necessary infrastructure, technology, resources and expertise, either developed in-house, through partners or acquired.

- Transform both internal and external processes and practices.
- Create a supportive environment and culture for constant innovation, aimed at revolutionising the customer experience and unlocking new business opportunities and models.

Apty (2022) posit that factors that affect digitalisation are: mindset and culture, leadership, talent of employees, training and support, communication. Verina and Titko (2019) identified the following factors as core for successful digital transformation: strategy; organisational culture and values; readiness of employees to accept changes; staff knowledge and competence; existing infrastructure (technology); financial (other) motivation system; and financial situation in the organisation. McCarthy et al. (2023) believe that strategy, leadership, digital infrastructure, professional development, empowering workers, communication, school culture are key factors that affect the digital transformation in education. Patterson (2021) reports that access to digital technologies (e.g., laptops, tablets, and mobile phones; Håkansson Lindqvist 2015; Hansson 2013), digital competence (e.g., pedagogic digital competencies, TPACK, ICT skills; Pettersson 2018a; Aesaert et al. 2015; Hatlevik and Christophersen, 2013; Krumsvik et al. 2016; Mishra and Koehler 2006), development of teaching and learning designs (e.g., flipped classrooms; Lund and Hauge 2011; Olofsson and Lindberg 2014), and organisational or institutional change (e.g., administrational and institutional support, ICT infrastructures, ICT leadership, and ICT school culture; Pettersson, 2018b; Blau and Shamir-Inbal 2017; Ottestad 2008; Vanderlinde and van Braak 2010) are key factors that influence digitalisation. UNESCO (2021a) recognises that the two main challenges that hinder the digitalisation process are: technical and material access to connectivity and inadequate digital skills and competencies. Manyengo (2021) claims that factors that influence digitalisation are: teachers' interest, teachers' knowledge and skills, policy, and access to the internet.

Strategy as an important component for successful digitalisation of education

McKinsey and Company's (2018) as cited in McCarthy et al. (2023) global survey on digital transformations found that, less than 30% succeed in delivering digital transformation as they envisioned. One of their findings was that all the organisations they reviewed in their study expressed a need for strategic planning, including adequate funding and resourcing to enable scale and sustainability of digital transformation. Le Pham (2021), Mai (2022a), OECD (2021) believe that a good digital strategy should generally start by a needs assessment. Successfully implementing digitalisation requires more than just reaction strategies and policies to solve current problems. OECD (2021), Riemke-Gurzki (2017) as cited in McCarthy (2020) believe

that the implementation of digital transformation in a sector begins with understanding social, economic, political and/or technological conditions and trends.

Digitalising a whole sector, such as education, necessitates a meticulously planned long-term strategy. According to the Ministry of Education Korea (2017), digitalising their educational sector was a long-term plan that was divided into 5 phases: 1st phase of base creation (1996-2000), 2nd phase of expanding and settlement (2001- 2005), 3rd phase of upgradability (2006-2010), 4th phase of integration of education and technology (2010-2014) and 5th phase (2014-2018).

OECD (2021) believes that the successful implementation of a digitalisation strategy for higher education requires four phases of action:

i. setting the direction: which involves understanding the needs and experiences of higher education staff and students, defining and communicating the strategy for digitalisation and developing a plan that will deliver on the strategy. It also involves including the costs of digitalisation in budgets and ensuring there are tools for measuring digitalisation and monitoring success in achieving the goals and objectives of the strategy.
ii. Building the foundation: this means providing and funding the digital infrastructure necessary to implement the strategy, including systems that allow for data to be collected, housed, managed and analysed. It includes, but goes beyond, digital infrastructure. It means ensuring there is a reliable network and the availability of skilled people to manage and maintain the infrastructure. It includes creating policies and standards, such as the requirement for interoperability of systems, uniform data quality processes and standards, and minimum hardware standards. To get value from the additional data generated by a digitalised higher education system implies ensuring that people are employed to analyse the data and communicate the analysis findings.
iii. Developing the processes: effective digitalisation implies changes in teaching, learning, research and engagement. This requires changes in both incentives and capabilities. Incentive systems – the funding of institutions and the remuneration and career advancement of individuals – need to be adapted to reflect the new opportunities, and the new tasks, created by digitalisation. Increasing capabilities requires a commitment to the training and support of staff.
iv. Delivering benefits to students, graduates and employers: Lastly, an effective digitalisation strategy requires that all actors within the higher education system – students, research consumers, employers – benefit from digitalisation. For students, this

means designing academic programmes that recognise learning outcomes from digital (as well as traditional) formats. It includes enabling students to have sufficient access to the information they need to support their learning. It means allowing them to study in flexible modes and ensuring that they graduate with the digital skills that employers want and expect of graduates in the 21st century. It also includes providing support for student learning and ensuring that delivery is designed to be interesting and enjoyable, as well as instructive (OECD, 2021).

MoE Montenegro (2022) posits that, with the broad nature of digitalisation of an educational system, it is necessary to develop an Education System Digitalisation Strategy to ensured planned development in this area.

Guidance in digitalisation strategy development in education can be taken from consulting organisations, policy makers, and influencing organisations, such as UNESCO, World Economic Forum (WEF), OECD, UNICEF.

Leadership as a vital component for successful digitalisation of education

McCarthy et al. (2023) think that leadership and ownership of digital transformation is required and recommend that the digital transformation leader, should be a strategic and equal member of the overall leadership team of the organisation implementing digital transformation. Manyengo (2021) believes that digital transformation needs a strategic leader to pioneer and champion its activities. Findings in the research of Cohen et al. (2019) shows that transformations are 5.3 times more likely to succeed when leaders model the behaviour, they want employees to adopt. They also found that nearly 50 percent of employees cite the CEO's visible engagement and commitment to transformation as the most effective action for engaging frontline employees. Leaders are key actors in the development of a digital culture: they need to create relationships with multiple and scattered stakeholders, and focus on enabling collaborative processes in complex settings, while attending to pressing ethical concerns (Cortellazzo et al., 2019). Ethical concerns such as access and use, privacy protection, trust generally arise in digitalisation processes since data can be managed by external consultants or technology suppliers. Leaders must thus think of governance policies to provide clarity about who has access to the data, where data are stored, and how it can be accessed (McCarthy et al., 2023). They further explain that another role of the leader is to communicate the vision and purpose of the digitalisation process such that it reunites and pushes all the stakeholders concerned (students, parents, teachers, support staff, principals, local community, and regional and system leaders) to come together and collaborate constructively with each person knowing

their roles. McCarthy et al. (2023) join Davies & Hentschke (2006) to add that, in education there is a need for public and private partnerships to effectively bring together the people, resources, and capacities to address or resolve education issues. Digital transformation requires leaders to navigate new and added partnerships that will be outside of the education sector, such as telecommunication companies to support connectivity, other government departments to integrate identity systems for users, and organisations to enable scale and sustainability of the digital transformation. The idea of partnership, agility, and trust is further supported by Michaelca (2017) in the statement: "the digital world requires a different form of leadership and management. The winning leadership capabilities of the future will include some of the traditional leadership traits of vision, courage, and humility, but increasingly an ability to drive a sense of purpose, build trust with internal and external stakeholders, adapt to change at warp speed, predict fierce competitors, and deal with significant and evolving risks". Research conducted by Allas et al. (2019) as cited in McCarthy et al. (2023) show that lack of leadership support has a significant negative impact on progress. Supportive leaders who recognize the needs, talents, and contexts of their community, and integrate these elements into their decision making are recommended for transformation success. Booth and Wigert (2019) in their findings report that the more principals coach their teachers (i.e., listen, provide feedback and celebrate exceptional performance), the better those teachers perform and the more engaged they are. And they believe that teacher engagement rapidly translates to student engagement and success. Booth and Wigert (2019) in their article thus propose that policies makers or decision makers should:

- Empower and educate principals to coach teachers to excellence.
- Hire talented principals. Their research showed that schools that hired talented principals, based on an objective talent assessment, were 2.6 times more likely to have above-average teacher engagement.
- Support principals with proven systems and policies. Leaders must demolish procedural obstacles and implement proven-effective methods -- like analytics-based attraction and performance development systems.

Reliable Digital Infrastructure as a vital component for successful digitalisation of education

Digital technology has become a social necessity to ensure education as a basic human right, especially in a world experiencing more frequent crises and conflicts. During the COVID-19 pandemic, countries without sufficient ICT infrastructure and well-resourced digital learning

systems suffered the greatest education disruptions and learning losses (UNESCO 2023a). Miao & al. (2022), Akumbu et al. (2021) Manyengo (2021), OECD (2021), UNESCO (2013), Ansoy (2022), McCarthy, Maor, & McConney (2023), NAICT (2007), Nsolly and Charlotte (2016), Haji et al. (2017), Le Pham (2021), Patterson (2020), MoE Korea (2017), UNESCO (2021b) all agree that digital infrastructure is the basic step and input in any digitalisation process.

UNESCO (2021a) reports that technical and material access to connectivity remain woefully insufficient with approximately two out of every three children and youth having no internet access at home. It also reports on the digital divide between countries, and claims that: "in high-income countries nearly 90 per cent of school-aged children and adolescents are connected. In low-income countries this figure is often under 10 per cent. And scarcity aside, connectivity in poor countries tends to be slow and unreliable, hampering its educational potential". MoE Montenegro (2022) emphasises the importance of digital infrastructure in the digitalisation process by placing it as a key objective directly after the improvement of legislation in their strategic goal 1 and goal 2.

Successful digitalisation does not rely only on infrastructure but also on people. This statement is supported by Haelermans (2017) as cited in Patterson (2020) that: "having access to ICT in education will not necessarily lead to an effective use of ICT in education".

Skilled human resource as a vital component for successful digitalisation of education

Human resources' is one of the pivot elements in business enterprises to achieve set goals and objectives of new millennium. Competent and skilled workforce have to be permanent stakeholders of a corporation where they use acquired knowledge and gained skills to achieve set milestones in particular industry. Talent management is the task of attracting, acquiring, developing and retaining skilled workforce to achieve desired goals of corporation (Shah, Memon & Tunio, 2021). Digitalisation can profoundly disrupt an organisation's status quo, requiring the development of new skills and mindsets. Collaboration, agility, innovation, and working creatively to utilise new capabilities are desirable attributes. However, recognising that the organisation may not have the capability or skills to drive digital transformation requires attracting new talent to lead, manage, and deliver the strategy (Mihalcea, 2017). McCarthy et al. (2023) support Mihalcea (2017) by advising that building internal capacity is crucial for transformation to be sustainable, such as ensuring technology related employees have the skills, capabilities, and capacity to accept handover from consultants to successfully execute and deliver digital transformation.

UNESCO (2021a) reports that inadequate digital skills and competencies rank as the single greatest barrier to technology use for education, and this regardless of a country's development status. Digital skills gaps tend to be most pronounced for parents, followed by teachers, followed by students, indicating that connected education is dependent on digitally literate societies. Opportunities to develop the knowledge and skills required to leverage connected technology for learning and other socially beneficial purposes need to be stepped up immediately, especially for girls and women who tend to have lower levels of digital skills than men and boys. Education is an important site for building digital skills and applying them. When learners, teachers and families have strong digital competencies, connected technologies become more versatile tools for education. MoE Montenegro (2022) report the findings of the Bureau for Education Services that indicates a modest level of ICT knowledge on the part of some IT teachers and the need for their continuous professional development, since changes in this area are constant and rapid. They further report on seminars and programmes on digital pedagogy. One of the key objectives in the strategy of MoE Montenegro is to raise the level of digital skills and competencies of employees in educational institutions.

Research performed by Akumbu et al. (2021), reveal that ICT skills of teachers is very low which makes them not prepared to undertake effective teaching using ICT. They believed that reasons for this is that teachers received very weak ICT training with no practical at their initial training, while no continuous training opportunities are provided. They recommend the following as regard development of ICT skills of the teaching personnel:

- Teachers Training Colleges should take the teaching of ICT with much seriousness, and make it more practical;
- continuous training or in service capacity building for teachers in the form of seminars should be organized with specific targets to develop online education skills at all levels of education.

Government of United Republic of Tanzania (2014) as cited in Manyengo (2021) reports that education can be delivered much more efficiently if ICT and human resources with requisite skills are effectively utilised. They explain that the main challenges as concerns human resource are poor application of ICT in teaching and learning; and scarcity of human resources capable of teaching distance education. The main reason for this is not the absence of digital skills but the integration of digital competencies into teaching and learning. Manyengo (2021) further reports that in 2011 and 2012, some secondary school teachers were provided a one-time training on pedagogical practices that integrate digital technology but argues that one-time

trainings have always proven ineffective to empower teachers to use digital technologies or integrate them in their pedagogical practices. He thus proposes the use of continuous pedagogical and technical support and mentoring at school level using skilled colleagues or hiring outside expert consultants. Manyengo (2021) studies further demonstrates that pre-service teacher education programmes related to digital technologies are not sufficient to prepare teachers to be effective users of digital technologies in the classroom and that teacher preparation programmes offer just one isolated course on educational technology.

Professional development and talent management is thus core in making sure teachers have the skills needed and are motivated to practice the skills learnt in the classroom. Mccarthy et al. (2023) express the importance of people in an organisation in the following statement: "supporting the development of people in education settings is often called professional development (PD) and involves a mix of strategy, training, and development within the profession. Other industries call the development of people training and place this within the journey of an employee, from recruitment to personal and professional development, certification, career management, performance reviews, and benefits, which is collectively called Talent Management. Talent management includes the use of digital tools, methodologies, and processes to enable organisations to get the best out of their most important asset, their people.

Booth and Wigert (2019) report that what teachers need to stay engaged are the following:

- principals who truly care - who never stop helping them reach their potential;
- pathway that celebrates and incentivizes exceptional performance;
- individualised opportunities to grow and a school culture that promotes excellence, not mediocrity.

Darling-Harmond (2017) propose the following practises as leading strategies for improvement of teacher learning.

- Recruitment of highly able candidates into high-quality programmes by ensuring competitive salaries, financial subsidies for training and greater commonality in the design and quality of preparation.
- Connecting theory and practice through both the design of thoughtful coursework and the integration of high-quality clinical work in settings where good practice is supported. Programmes in Finland, as well as a growing number of institutions in

Canada, Australia and the United States, have created new models for student-teaching, often in 'training schools' or professional development schools.

- Using professional teaching standards to focus attention on the learning and evaluation of critical knowledge, skills and dispositions.
- Creation of teacher performance assessments, based on professional standards, which connect student learning to classroom teaching.
- Establishing induction models that support beginning teachers through skilful mentoring, collaborative planning and reduced teaching loads that allow time for in-service seminars and careful building of a repertoire of practice.
- Supporting thoughtful professional development that routinely enables teachers to learn with and from one another, both within and across schools and universities.
- Profession-wide capacity building, like that underway in Ontario, Canada and Singapore, which creates strategies for wide sharing of research and good practice, recognises successful classroom and school practices and enables expert teachers and principals to provide leadership to the system as whole.

Policies as an important component of digitalisation of Education

UNESCO (2013) expresses the difference between policy, strategy and plan. They report that, an education policy establishes the main goals and priorities pursued by the government in matters of education at the sector and sub-sector levels with regard to specific aspects such as access, quality and teachers, or to a given issue or need. A strategy specifies how the policy goals are to be achieved. A plan defines the targets, activities to be implemented and the timeline, responsibilities and resources needed to realise the policy and strategy. Miao et al. (2022) differentiates ICT in education policies from masterplans. They define ICT in education policies as multiple forms of public policies for leveraging approaches that blend human resources, hardware, software, and digital content and applications to expand access to education opportunities and enhance the relevance and quality of learning, while promoting digital skills. A masterplan is an operational theory of change and a dynamic time-binding and result-based policy action plan that provides a conceptual layout on developmental objectives to be achieved in identified focus areas. It features mid-or long-term plans for mobilising resources, coordinating implementing agencies, and steering concerted actions. An ICT in education masterplan should start with a review, adjustment or reform of relevant governance mechanisms and legal arrangements to ensure the protection of human rights and dignities, regulation of practices, and mitigation of potential risks. A well-designed masterplan should

then establish an institutional coordination architecture to direct the agencies that will implement the plan and oversee the implementation, define the results and targets for each focus area, develop detailed costing and budgeting plans to ensure sustainable funding resources, and set out a phased implementation schedule as well as an evaluation and monitoring mechanism. MoE Rwanda (2015) define a masterplan is a blue-print or roadmap for using ICTs to transform education. It describes the overall plan for how technology will be integrated and used by schools, teachers, student, administrators and even parents to increase access, improve the quality and prepare students for the 21st century. The Masterplan will be the guide for setting priorities, focusing resources, align all Stakeholders, tracking performance and achievements and managing change. Miao et al. (2022), OECD (2021) report that there should be specific policies to support the digital transformation of education.

The aim of the public ICT in education policies proposed in this publication is to promote the adoption or implementation of global governance effects under local contexts, to counterbalance the private governance imposed by digital platforms or applications, and to regulate stakeholder practices to protect the human rights, data privacy, and digital security of all users of ICT in education. Further, the purpose is to leverage technological innovation to support the achievement of sectoral, intersectoral, or subsectoral strategic objectives of education systems within the framework of SDG 4 – Education 2030. This also includes the future of education beyond 2030, under both normal and crisis situations.

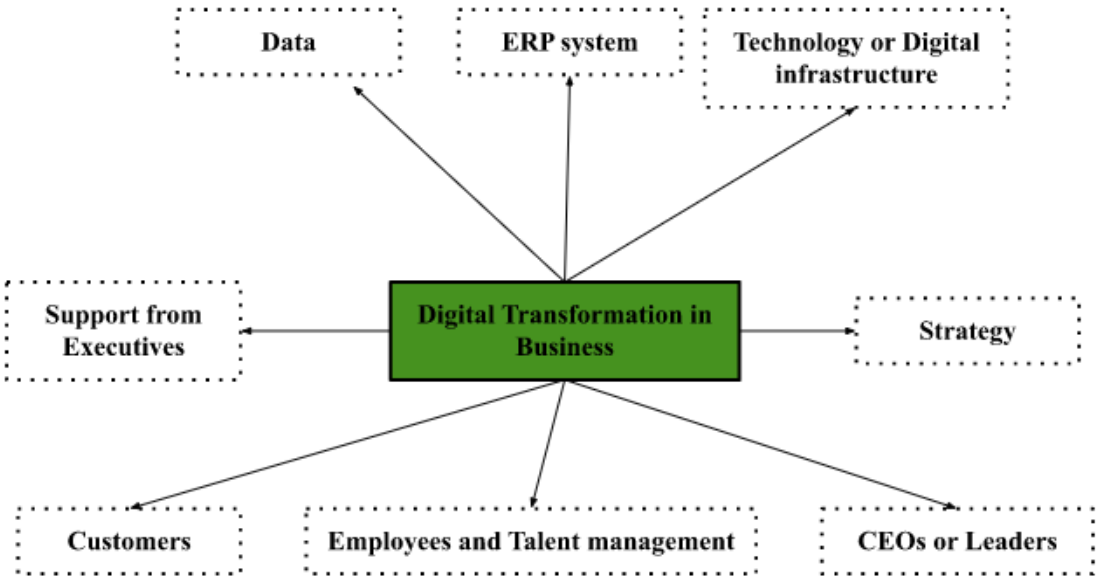
UNESCO (2013) believes that policies relating to the use of ICT in education can be found embedded in a wide range of educational areas that include education policy, teacher education, teaching and learning, non-formal education, monitoring and measuring change, research and knowledge sharing, and cross sectoral ICT programmes.

Concept Map

The main concepts linked to the digital transformation of the industry are provided in Figure 1.

Figure 1

Concepts linked to digital transformation in the industry

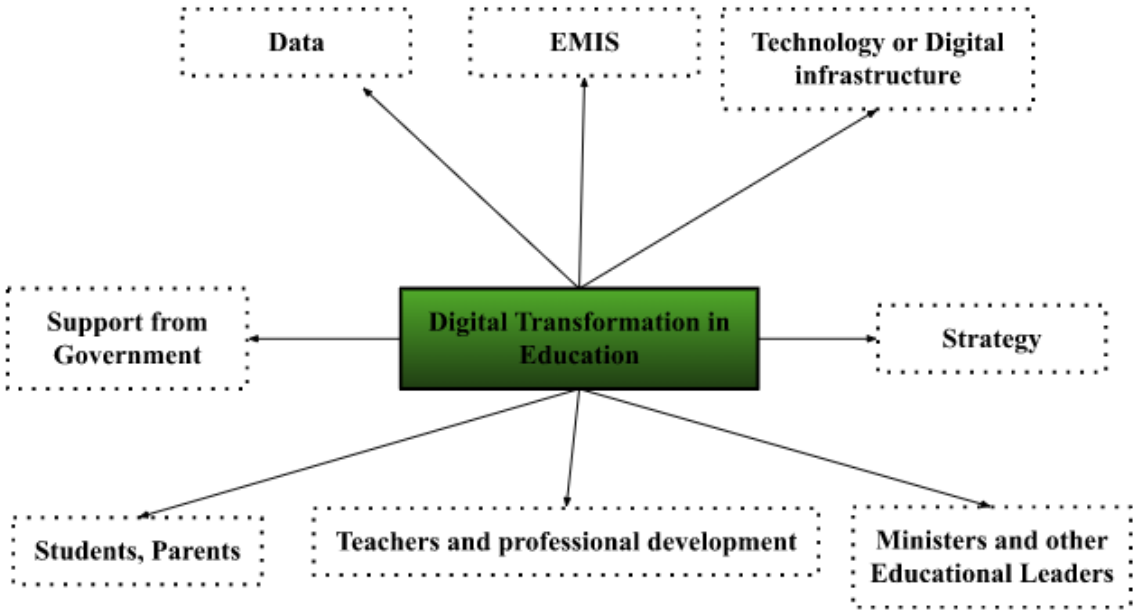


Source: adapted from Verina and Titko (2019)

A transposed version of Figure 1 to an educational context is expressed in Figure 2.

Figure 2

Concepts linked to digital transformation in education



Source: author

Theoretical Framework

Digitalising education is a process that deals with people and culture and thus involves social change. Social change is the process whereby individuals and communities adjust or abandon customs and associated leading ideas, values, and purposes to act differently in response to random or systemic factors (Asian Development Bank, 2017). Change theories help to understand and navigate the complexity of social change. Moreover, digitalising education in Cameroon has mostly gone through the launching and implementation of programs. A programme is defined as related projects, subsidiary programmes, and programme activities managed in a coordinated manner to obtain benefits not available from managing them individually (PMI, 2017). This study will thus be supported by change theory, specifically Kurt Lewin's change model of unfreezing, changing, and refreezing, and a programme management model, specifically the model proposed by the Project Management Institute (PMI) in their book Standards for Programme Management.

Change Management

The most successful digital transformations start with a shift in mindset at the employee, leadership, and organisation levels. This shift produces a culture change that allows the company to be more agile, risk-tolerant, experimental, and collaborative (Kane, 2019). Change management is "the application of a structured process and set of tools for leading the people side of change to achieve a desired business outcome; it is both a process and a competency" (Creasy, 2018). Change management is a widely accepted methodology to help organisations successfully implement substantial transformation and may be used to alter anything from the organisational structure or business environment to technology or job roles (Galli, 2018). Programmes introduce change throughout their duration. This change may be reflected in the introduction of a new product, service, or organisational capability. Changes may be introduced to a variety of business processes (for example, the processes required to provide a new or improved service) through the actions, guidance, and leadership of the programme manager (PMI 2017).

Lewin believed that any level of behaviour is maintained in a condition of quasi-stationary equilibrium by a force field comprising a balance of forces pushing for and resisting change. This level of behaviour can be changed by either adding forces for change in the desired direction or by diminishing the opposing or resisting forces. Lewin preferred the method of achieving change that is based on reducing the restraining forces in preference to increasing the

forces pushing for change (Schein, 1995). He argued that approaches involving the removal of restraining forces within the individual, group, or organisation are likely to increase commitment and result in more permanent change than approaches involving the application of outside pressure for change. Lewin's theory of change is a three-step process: unfreezing, changing, and freezing. Managing change thus involves unlocking the existing level of behaviour, moving to a new level, and then refreezing the behaviour at this new level (Schein, 1995).

Unfreezing is the stage where the balance between driving and restraining forces is destabilised. Many authors in literature have provided different ways of unfreezing. Kotter (1995) argues that the current state of equilibrium can be destabilised by alerting organisational members to the need for change. Creating a vision of a more desirable future state and providing information that creates a sense of urgency. Schein (1995) proposes that providing disconfirming information that arouses survival anxiety can motivate change.

Lewin's second stage of changing or moving is where the balance of driving and restraining forces is modified to shift the equilibrium to a new level. Although these forces can assume many forms, they tend to manifest in terms of behaviours that affect performance (Ford & Greer, 2006). Consequently, movement tends to be achieved by adjusting attitudes and beliefs and modifying the processes, systems, and structures that shape behaviour (John Hayes, 2014).

Refreezing involves reinforcing new behaviours in order to maintain new levels of performance and avoid regression. Feedback that signals the effectiveness and consistency of new behaviours and incentives that reward new levels of performance can help enshrine new practices (Schein, 1995; Hayes, 2014).

Implications of Kurt Lewin's Change Theory to the present study

This theory of change has been adopted for this study because the digitalisation of secondary education is a long-term process that involves a change of methods and perspectives by a variety of stakeholders (teachers, students, parents, administrators, and policymakers). Thus, managing change is an indispensable factor. Moreover, this theory provides a framework to manage change in a way that reduces restraining forces and thus resistance from stakeholders. The freezing stage ensures that the change obtained is long-lasting and sustainable.

Program management model

ProjectManager (2023) defines a programme management model as a strategic management approach to executing and controlling multiple related projects. Programme management can be conceptualised as a controlling instance for a transformation process, i.e., the design, development, and deployment of changes to the organisation, following a result that in turn is governed by projects (Ribbers & Schoo, 2002). PMI (2017) defines programme management as the application of knowledge, skills, and principles to a programme to achieve the programme objectives and to obtain benefits and control not available by managing programme components individually. Programme management involves the alignment of programme components to ensure that programme goals are achieved, and programme benefits are optimally delivered.

Ribbers and Schoo (2002) believe that the success of software implementation is dependent on the design of program management, whereas the latter is affected by the complexity of the software implementation. Digitalising a complex system such as secondary education is thus highly dependent on programme management. Ribbers and Schoo (2002) propose three measures of complexity: variety, variability, and integration. Variety reflects the number of elements and their interrelationships in a given situation or system. In an implementation programme, variety will increase with, for example, the number of sites affected, or the functions of a package implemented. The variability of a system relates to the dynamics over time of its elements and the interrelationships between them. Examples of variability in an implementation programme are scope changes, a lack of resources, or dependencies on other programmes that are competing for resources. Integration characterises the planned changes to be realised through the implementation programme in terms of the integration of IT systems and across business processes. This measure describes the degree of innovation in IT and business processes that is to be implemented through the programme. Innovation factors include, for instance, new cooperations with customers and suppliers and the sophistication and newness of the technology to be introduced. Ribbers and Schoo (2002) measured success at two levels: project success and product success. Product success was measured through the following indicators: level of use of the new system and procedures; level of contribution of the programme deliverable to the company; and project success through level of adherence to the time plan and level of adherence to budget.

Ribbers and Schoo (2002) identified the following as key elements of programme management: programme organisation, policies, plans, communication, and alignment.

- Programme organisation—the structural organisation of a team that plans and controls projects in the programme and the related resources.
- Policies—that guide programme management to perform within given budgets, deadlines, required acceptance levels, and goal adherence.
- Plans—that take the implementation goals and drive the projects within the programme;
- Communication—as a means of providing information to teams and users to solve problems within the teams.
- Alignment—the process of adapting the information system to the organisation or vice versa, in line with the business direction.

To ensure success in a programme, Ribbers and Schoo (2002) proposed the following:

- teams in complex implementation programmes should be structured such that they cover all of the following roles: programme manager, steering committee, programme sponsor, user representative, coordinator across projects ("global process owner"), coordinator with external suppliers, coordinator for an efficient implementation process ("site implementation manager"), and independent quality assurance;
- a loose budget policy, in terms of time and cost restrictions, in the innovation phase (visioning, software selection, test, and pilot) should be implemented;
- the number of parallel implementation projects should be adjusted based on the resources available;
- sponsorship should penetrate all levels within the organisation;
- use of alignment mechanisms and tools such as steering committees, programme reviews, etc.

PMI (2017) provides key types of complexity to deal with when managing programmes. These complexities are:

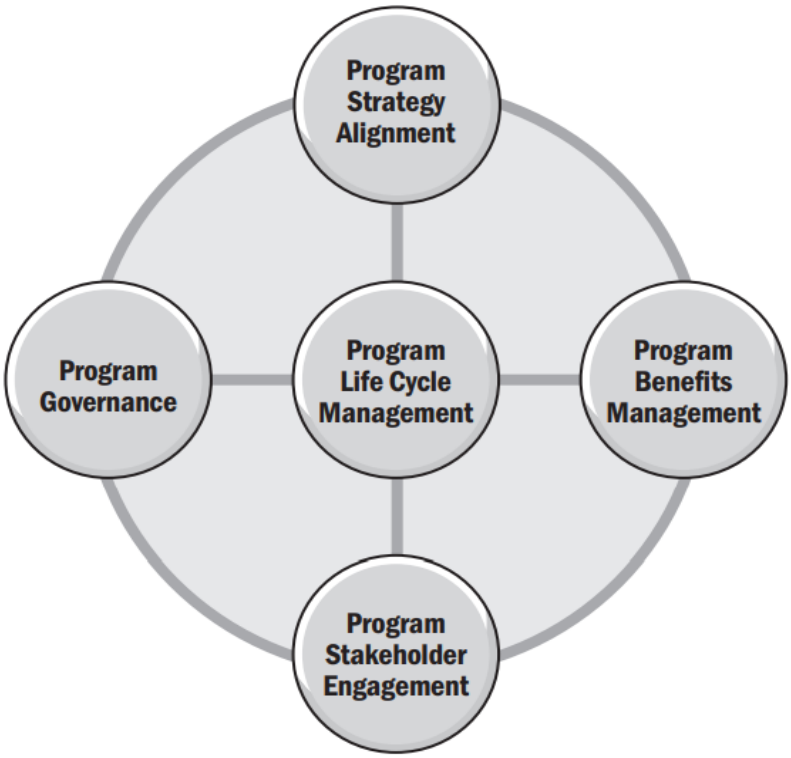
- Governance complexity: it results from the sponsor's support for the programme as well as the support of the related components' sponsors, management structures, the number of organisations involved, and the decision-making processes within the programme.
- Stakeholder complexity: it arises from the differences in the needs and influence of stakeholders, which may be a burden to the programme or in conflict with the benefits of the programme. Stakeholder complexity also focuses on the programme team itself and the diversity within the programme team. Stakeholder complexity is also associated with the number of stakeholders interested in the programme.

- Definition complexity: programs bring about change, and definition complexity focuses on the agreement of the future state by stakeholders. Other aspects that the programme manager should be cognizant of include benefits management and the potential competing interests of stakeholders.
- Benefits delivery complexity: it focuses on benefits management.
- Interdependency complexity: it focuses on the interdependencies among components and not necessarily on issues within individual projects. Programmes strengthen and enforce interdependencies among components to ensure that the overall outcome of the programme delivers the intended benefits. Interdependencies among components and other business entities should be clearly defined. Interdependencies can also occur outside the programme when there are dependencies on other projects or programmes as well as dependencies external to the organisation. Interdependencies are directly related to the complexity of the programme.
- Resource complexity: it focuses on the availability of resources at the required level of capability and capacity; adequate funding; and suitable supplies and materials add to the complexity of the programme, and these resource concerns need to be addressed within the programme.
- Scope complexity: it arises from the difficulty of clearly defining the deliverables and benefits of a programme and its components. Managing the delivery of the associated benefits beyond the lifespan of the programme's components contributes to scope complexity.
- Change complexity: it arises from the different levels of impact that change can potentially cause in an organisation. Change complexity is low when a programme changes the basic operational process model in one or two departments, but it can be extremely complex when a programme transforms an organisation from a functional to a projectized organisation.
- Risk complexity. it arises from the high level of uncertainty due to the extended programme life cycle and the uncertainty of the components' outcomes and their interdependencies.

PMI (2017) provides a rigorous framework with best practices to guarantee programme success. This framework is based on five performance domains, as shown in Figure 3.

Figure 3

Performance domains in program management



Source: Project Management Institute (2017)

- Programme Strategy Alignment is a performance domain that identifies programme outputs and outcomes to provide benefits aligned with the organisation's goals and objectives.
- Programme Benefits Management is the performance domain that defines, creates, maximises, and delivers the benefits provided by the programme.
- Programme Stakeholder Engagement is the performance domain that identifies, and analyses stakeholder needs and manages expectations and communications to foster stakeholder support.
- Programme Governance is the performance domain that enables and performs programme decision-making, establishes practices to support the programme, and maintains programme oversight.
- Programme Life Cycle Management is the performance domain that manages programme activities required to facilitate effective programme definition, programme delivery, and programme closure.

Programme management performance domains run concurrently and interact with each other throughout the course of the programme. How much interaction there will be and when it should occur will depend on the programme and its components. The amount of interaction for any given programme is as varied as the number of programmes that exist. When organisations pursue similar programmes, the interactions among the performance domains are similar and often repetitive. All five domains interact with each other with varying degrees of intensity. These domains are the areas in which programme managers and the programme team will spend their time while implementing the programme and performing their activities. The nature and complexity of the programme being implemented determine the degree of activity required within a particular domain at any particular point in time. Every programme requires some activity in each of these performance domains during the entire course of the programme. Work within these domains is iterative in nature and is repeated frequently. The five domains reflect the higher-level business functions that are essential aspects of the programme manager's role regardless of the size of the organisation, industry or business focus, and/or geographic location.

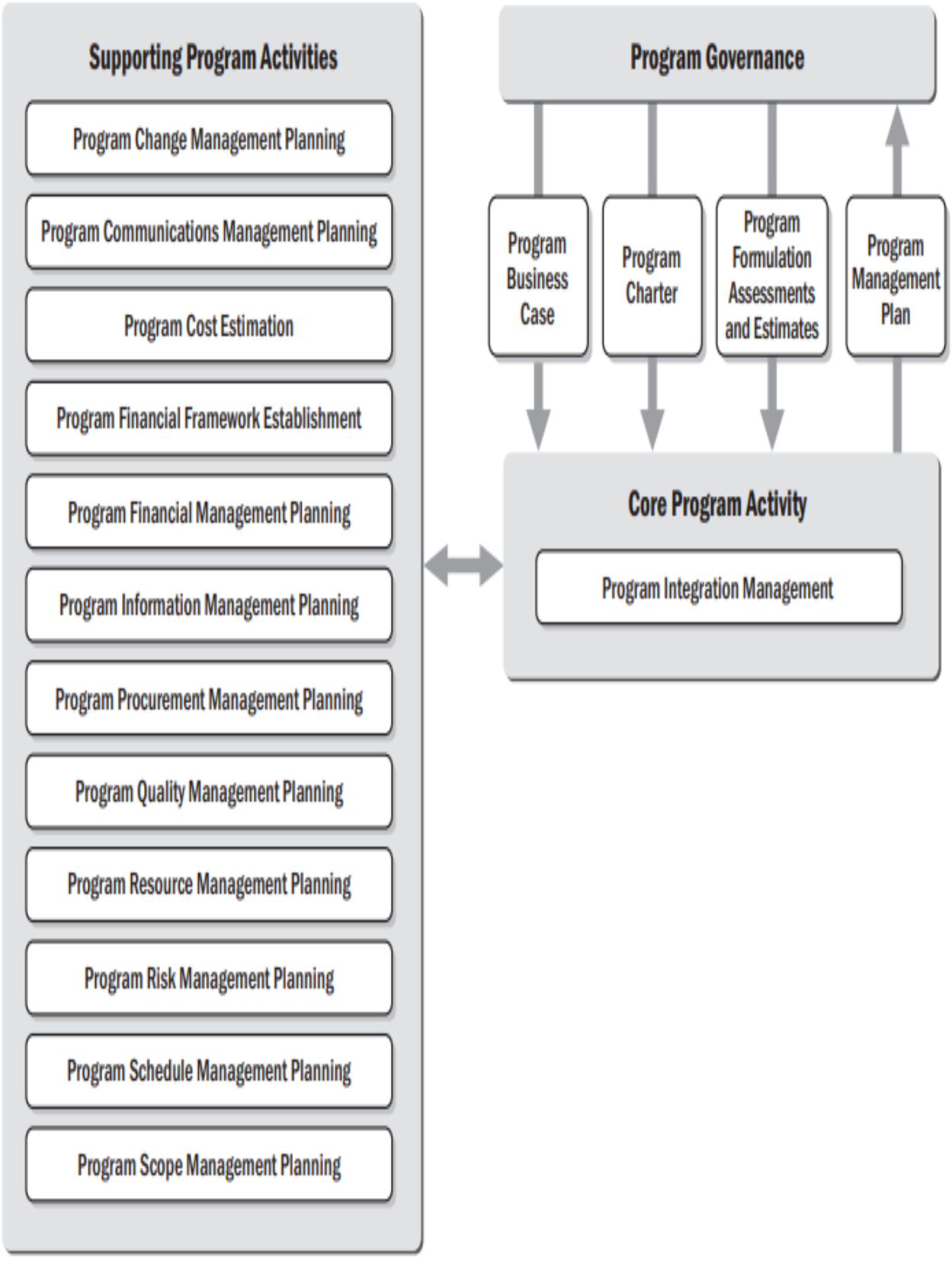
PMI (2017) proposes three main phases in the programme life cycle, with each phase having a set of activities. These 3 phases are: programme definition, programme delivery, and programme closure.

- Programme Definition Phase: this phase consists of programme activities conducted to authorise the programme and develop the programme roadmap required to achieve the expected results. As part of programme definition, the programme business case and programme charter are formulated. Once approved, the programme management plan is prepared.
- Programme Delivery Phase: it comprises the programme activities performed to produce the intended results of each component in accordance with the programme management plan. Throughout this phase, individual components are initiated, planned, executed, transitioned, and closed, while benefits are delivered, transitioned, and sustained.
- Programme Closure Phase: this phase includes the programme activities necessary to transition the programme benefits to the sustaining organisation and formally close the programme in a controlled manner. During programme closure, the programme is transitioned and closed or ended early, or work is transitioned to another programme.

Activities performed during program definition, program delivery, and program closure phases are depicted in Figures 4, 5, and 6 respectively.

Figure 4

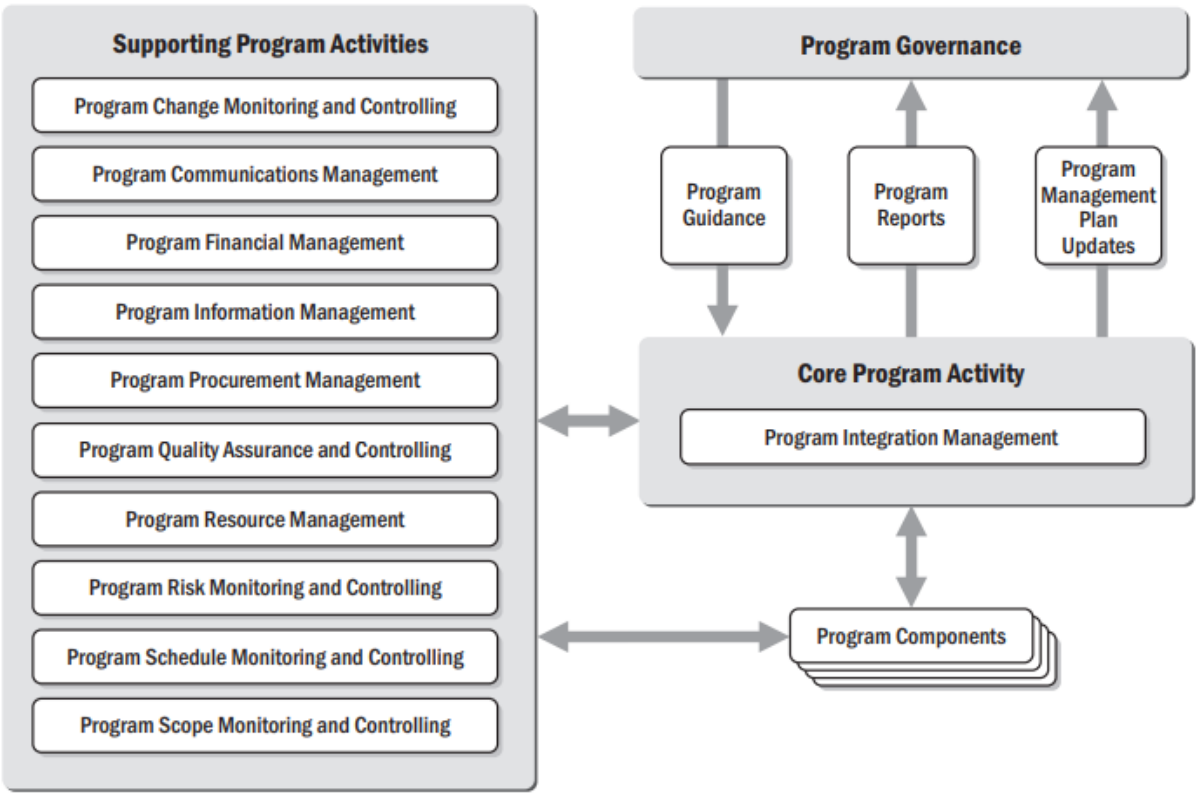
Program planning phase activity interaction



Source: Project Management Institute (2017)

Figure 5

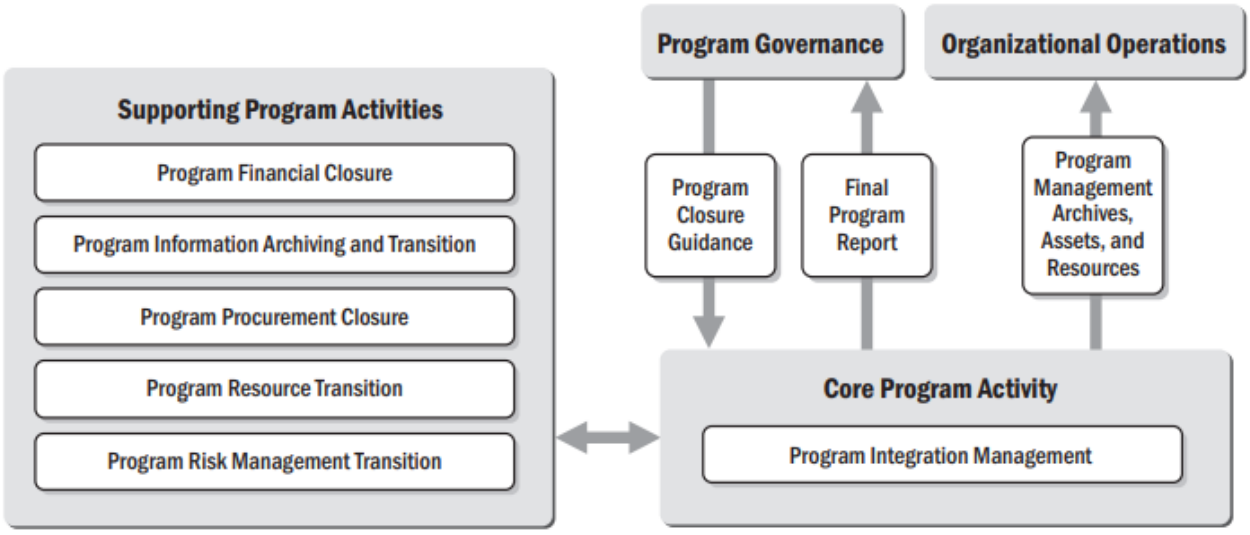
Program delivery phase activity interaction



Source: Project Management Institute (2017)

Figure 6

Program closure phase activity interaction



Source: Project Management Institute (2017)

Implications of program management model to the present study

Programme management model, specifically the model proposed by PMI, an authority in programme management, will act as a yardstick to comment on the digitalisation framework or process used by the Ministry of Secondary Education in Cameroon. Levin and Green (2014) and Ribbers and Schoo (2002) affirm that success in programmes requires appropriately complete plans, well-run meetings with meaningful agendas, accurate record keeping, and general adherence to global best practices, which are elements provided in the PMI framework for managing programmes. This model was also chosen because it explicitly recognises the importance of managing change in programme management. Moreover, it will help to identify or corroborate pain points in the current management of programmes for digitalising secondary education in Cameroon and help recommend methods of dealing with the pain points.

Review by objectives

Digitalisation efforts instituted by MINESEC and existing policies

A lot of countries, such as Korea, Montenegro, Cambodia, Mongolia, Hungary, Ireland, Malaysia, Singapore, Rwanda, Zambia, South Africa, etc., have created or reviewed policies and masterplans for the digital transformation of their educational systems (UNESCO 2023b, UNESCO 2015). These policies and masterplans dealt with salient elements of the digitalisation of education, such as the production of digital resources, providing access to educational resources through a distance education platform, monitoring and evaluating digital transformation, building an EMIS, defining competency frameworks for teachers, and more. According to UNESCO (2015), most African countries do not have a policy or plan for the integration of ICT in education.

Cameroon did not have a plan and does not have one even today. In 2007, NAICT produced a document entitled ‘National Policy for the Development of Information and Communication Technologies, which aimed at providing the following:

- a comprehensive framework for ICT development in line with national development objectives;
- a framework for consultation and concerted action with the private sector, civil society, and development partners;
- a framework for coordinating government action and external support, notably from the Digital Solidarity Fund (NAICT, 2007).

This plan was not focused on education alone. The educational sector was highlighted in this plan, and the following efforts were mentioned:

- the setting up of an inter-ministerial committee on the development of ICT in the education sector;
- a commitment to generalise the training in ICTs of all products (pupils, students) in the Cameroonian educational system by progressively introducing ICT courses at all levels (schools, colleges, universities);
- several initiatives by development partners, such as the Canadian cooperation, the French cooperation, and the Islamic Development Bank, to support the development of ICTs in the educational sector;
- the construction of multimedia resource centres (16) in some public schools with access to the internet;
- the construction of a telecommunication network linking all the state universities and institutes of higher learning and the development of a data sharing resource centre, the inter-university centre for information and communication technologies;
- the connection of all higher education and research institutes to the internet;
- the setting up of a virtual library (inter-university documentary resource centre), which has ushered into the higher education landscape innovative facilities that have apparently improved the quality of educational services (distance education) offered by these institutes;
- the putting in place of computerised educational management information systems (EMIS) (NAICT, 2007).

From the efforts mentioned, those that depended on the Ministry of Secondary Education were the introduction of computer science as a subject, the creation of Multimedia Resource Centres, and the training of teachers which are also mentioned in Josue (2007), Nsolly and Charlotte (2016), Haji (2015), Haji et al. (2017), Tchamabe (2010, 2011b, 2013), and Feugueng et al. (2015).

Josue (2007) also mentioned the CAM-EDUC platform, the NICI plan, which was developed in 2004 by the government with support from the United Nations Development Programme (UNDP) and the United Nations Economic Commission for Africa (UNECA), and other efforts with NGOs and other organisations. These efforts are either finished or have been discontinued. Tchamabe (2010) mentions the 1990 project called SOFATI aimed at computerising some technical schools. This project was carried out by the Canadian cooperation. She also mentions

the following: the PARAFOP project in 2007 which aimed at constructing specialised rooms in technical schools; the e-school project launched in 2008 by NEPAD.

Nkwenti and Abeywardena (2019) mention efforts made to sensitise and encourage pedagogic supervisors of MINESEC and MINEDUB to mainstream Open Educational Resources (OERs) in the teaching and learning process. Feugueng et al. (2015) mentions the creation of a virtual library in 2011 and trainings on the use of digital platforms, promotion of the use of ICT by mathematics teachers organised by the Government in partnership with MTN Cameroon. Some of these efforts have been completed or discontinued.

Pain points of digitalising education in the Ministry of Secondary Education

NAICT in 2007 identified the following pain points linked to the integration of ICT in education.

- Virtually all primary and secondary schools don't have any Multimedia Resource centres. Consequently, a larger percentage of students in the educational system leave without any initiation into the usage of ICTs. For instance, about 44% of pupils drop out of school before completing the primary level, while less than 4% get into the higher education cycle.
- The computer/student ratio in the higher education sector is relatively low, thereby preventing a favourable training environment for ICT usage for all the students. So, less than 5% of these students use ICTs in the learning process.
- The high cost of acquisition and functioning of ICT equipment makes it impracticable to provide universal training on ICTs.
- Most of the lecturers don't have any training in the ICT domain.
- The use of ICTs to improve the teaching and learning processes is still very rudimentary in the educational system. For instance, most of the websites are static, providing no interactive services to users, and some have obsolete contents, a virtual absence of didactic materials, uncomputerised management and guidance systems.
- Research centres and institutes are not well equipped with ICTs.
- Scientific production is still rudimentary, with no specific vision.
- The production and deployment of interactive didactic materials are completely absent in the educational system.

Nsolly and Charlotte (2016) mention the following as the main challenges of digitalising secondary education: chronic lack of infrastructure and equipment; inadequate number of

qualified and trained teachers; lack of support from school administrators; knowledge and skills of school administrators and in-service subject teachers; absence of a clear vision and planned strategy for ICTs in education; attitudes and beliefs of teachers and parents.

Haji (2015) investigates teachers' attitudes towards the use of ICT in schools, and this study revealed that teachers attributed negative attitudes towards the use of ICT to the following factors: the failure of school management to view ICT as a priority, inadequate or no training of staff, and a lack of technical support associated with the use of ICT. Haji et al. (2017) mention the fact that there is no clear, recognisable national strategy plan for the integration of modern technology within the school curricula and pedagogical activities, poor ICT infrastructure, and reticence to change. Also, the findings of Haji et al. (2017) reveal that teachers' perceived ICT usage, perceived access to ICT, perceived ICT competence, and perceived ICT training support are low.

Josue (2007) mentions pain points related to policy development, power struggles, insufficiencies in training, the potential of reducing student performance in orthography and grammar, non-inclusiveness, the absence of a coordinating unit, sustainability issues, insufficient infrastructure, and little access to distance learning facilities and platforms. Tchamabe (2010) mentions issues of integration of ICT that are related to infrastructure, norms and standards, overcrowded classrooms, movement of students to digitalised rooms, absence of shared vision, poor coordination between actors and risk of increasing the digital divide. Tchamabe (2011) points out additional issues such as the unequal distribution of services, high cost of internet, and absence of electricity. Tchamabe (2013) also mentions risk of increasing digital divide and talks about a different kind of digital divide which she calls eco-digital divide explains how unfavourable ecological environment in some areas can cause ICT devices to develop faults.

Akumbu et al. (2021) in their study highlight the absence of skills in online learning, insufficient infrastructure, and the willingness of teachers. Nkwenti and Abeywardena (2019) mention barriers linked to the mainstreaming of OERs by pedagogic supervisors. These barriers are computer skills to search for OERs; skills to adapt different OERs; and skills to interpret the different OER licences. Feugueng et al. (2015) mentions issues related to insufficient skills of teachers, reticence of teachers to integrate ICT in their teaching practices, large classroom sizes, teachers lack computers, insufficiencies in preservice training of teachers. MINESEC (2017) mentions how the poor management of computing projects funds is a major drawback to the integration of ICT in the educational system.

Proposed Solutions to ensure successful digitalisation of Secondary Education

Miao et al. (2022) provide a framework for managing the digital transformation of education as a whole and frameworks for managing specific key components in the digital transformation process. Other key recommendations on dealing with issues related to the digital transformation of education are mentioned in OECD (2021), Montenegro (2021), MoES Mongolia (2021), MoE Korea (2017), MoE Rwanda (2015), Manyengo (2021), Nsolly and Charlotte (2016), Haji (2015), Josue (2007), Akumbu et al. (2021), and Kane et al. (2015, 2017, 2019a, 2019b).

In Cameroon, Josue (2007) proposes the following: the setting up of a unit in charge of the teaching of ICTs in schools; governments should allot budgets to schools to support ICT integration projects. Tchamabe (2010) mentions the necessity for a coordination unit, shared vision, development of national policy on ICT integration, and appropriate infrastructure. Nsolly and Charlotte (2016) propose the following: a shared vision and technology integration plan; professional development of pre-service and in-service teachers; developing medium- and long-term development plans; sponsoring ICT integration projects; equipping schools with necessary infrastructure (electricity, internet access, computers, etc.); performing more research on the integration of technology in education; and learning from other countries that have already digitalised their education systems. Some key recommendations in Akumbu et al. (2021) are that: teachers' training colleges should take the teaching of ICT with much seriousness and make it more practical; schools should be equipped with multimedia resource centres and sufficient telecommunication dispositions; the State should develop a digital education sector policy to resolve the problems of possession and appropriation by all the actors of the educational community, and teachers in particular; and continuous training or in-service capacity building for teachers. Feugueng et al. (2015) outline three key factors for successful digitalisation: public policy, infrastructure, and professional development of teachers. He also proposes that MRCs are inappropriate for digitalising the classroom and proposes a movable set of computing devices. He also adds the following: equipping teachers with computers, integrate ICT and techno-pedagogic oriented courses in the training of preservice teachers, and review educational policies such that they integrate the use of educational technologies in education. Haji (2015) proposes recommendations to ameliorate teachers' attitudes towards the integration of ICT in education: professional training (both in-service and pre-service) should be provided for teachers to equip them with the required digital; the government needs to adopt and implement policies that enhance the acquisition and use of ICT by teachers; and the government has to perform actions that encourage teachers to use ICT more.

Empirical Review

A mixed study was conducted in Hungarian higher institutions by the EU commission, Hungarian government, and OECD in 2021. Data collection was done through a survey targeting more than 3000 staff that yielded more than 1000 complete responses. Also included are focus groups made up of 8 participants, interviews with twenty-nine key stakeholders, including higher education institution (HEI) leaders, staff, and students, as well as business, innovation, and research leaders, roundtable discussions with thirty-six representatives of higher education institutions, and an international expert meeting on the measurement of digitalisation in higher education; gathering approximately fifty-five participants and including presentations by experts from Hungary, Germany, Ireland, and the Netherlands. The study aimed at examining the following: the current state of digitalisation in Hungarian higher education, public policies and institutional strategies that may be developed to promote Hungarian higher education's digital readiness and performance, indicators that may be helpful to measure the digital readiness of higher education in Hungary, digital practices of students and staff, and the performance of digital higher education.

This study highlighted the infrastructural progress and policy framework defined by the Hungarian government. It also highlighted the following areas as those that need improvement: support for teachers and students in using digital technologies and poor data collection on digital practices, thus making it difficult to monitor progress and identify areas for improvement and investment. Based on an analysis of current policies in Hungary and drawing from international experience, this report provided 12 recommendations across 4 areas that the Hungarian government, in close collaboration with HEIs, may consider. The areas and their respective recommendations are provided in Table 1.

Table 1

Areas of improvement and recommendations proposed in OECD (2021)

Area	Description	Recommendations
A1 Setting the direction: Policy framework	This means understanding the needs and experiences of higher education staff and students, defining and communicating the strategy for digitalisation and developing a plan that will deliver on the strategy. It involves including the costs of digitalisation in budgets and ensuring there are tools for measuring digitalisation and monitoring	**R1**: Create mechanisms to build (and regularly revisit) an understanding of higher education staff and students' digital practices, needs and attitudes to inform policy. **R2**: Review the regulatory and funding framework for digitalisation in higher

	success in achieving the goals and objectives of the strategy.	education to encourage institutional strategies that support the take-up of digital practices among students and staff. **R3**: Encourage institutions to draw on best practices, from Hungary and other countries, in planning for and rolling out the digitalisation of higher education. **R4**: Design a plan for collecting and analysing data on digitalisation in teaching and learning.
A2 Building the foundation: Digital infrastructure and data systems	This means providing and funding the infrastructure necessary to implement the strategy—infrastructure that allows for data to be collected, housed, managed, and analysed. It means ensuring there is a reliable network, the availability of skilled people to manage and maintain the infrastructure, creating policies and standards, such as the requirement for interoperability of systems, uniform data quality processes and standards, and minimum hardware standards, and defining systems to analyse the data and communicate the analysis findings.	**R5**: Reconsider the centralised approach to ICT systems procurement and collaboratively develop with HEIs criteria to support well-informed digital infrastructure strategies and investments. **R6**: Consider targeted funding to expand access to hardware and software and increase the capacity of HEIs to provide support to students and staff. **R7**: Create data policies and standards
A3 Developing the processes: Teaching, research and engagement	Effective digitalisation implies changes in teaching, learning, research, and engagement. This requires changes in both incentives and capabilities. Incentive systems—the funding of institutions and the remuneration and career advancement of individuals—need to be adapted to reflect the new opportunities and tasks created by digitalisation. Increasing capabilities requires a commitment to the training and support of staff.	**R8**: Strengthen supports for higher education staff to expand the adoption of digitally enhanced, student-centred pedagogies **R9**: Revise the employment framework for Hungarian higher education staff to reward quality digital teaching and identify and disseminate examples of excellent teaching **R10**: Explore the potential of using learner analytics to lift learner success

A4 Delivering benefits to users: Students, graduates and employers	A digitalisation approach needs to ensure that actors within the higher education system—students, researchers, consumers, and employers—benefit from digitalisation. For students, this means enabling them to have sufficient access to the information they need to support their learning, allowing them to study in flexible modes, ensuring that they graduate with the digital skills that employers want and expect of graduates in the 21st century, providing support for student learning, and ensuring that delivery is designed to be interesting and enjoyable, as well as instructive.	**R11**: Engage in analysis and research into problems of access to higher education among some groups and develop interventions to enhance equity of access. **R12**: Analyse patterns of students' take-up of and achievement in online learning

This study conducted by the OECD in 2021 also affirmed that OECD countries face difficulties in measuring how much digitalisation is taking place in their higher education systems due to a lack of data. They noticed that the lack of system-level data on digitalisation stemmed from the following 3 factors: the low priority placed by the government on monitoring digitalisation, the difficulty of coordinating all the diversified practises in the different institutions, and the need for adequate, and potentially costly, data collection tools to help understand the practices and attitudes towards technology of higher education students and staff. They then gave three key methods for measuring the digitalisation of higher education used internationally, which are: national administrative data collection; surveys of higher education students and staff; and learning analytics.

Another mixed study aimed at developing a Digitalisation strategy for education in Montenegro was conducted in 2021 by UNICEF. Data in this study was collected through various focus groups with target groups such as teachers, school administration employees, companies, State institutions, higher education institutions, representatives of educational institutions, ICT coordinators, and non-governmental organisations. Interviews were held with children with special educational needs and the parents of children with special educational needs. An online survey was conducted on teachers' attitudes when it comes to digitalising education. The results of the SELFIE survey (European Commission methodology) from two academic years (one before and one during the COVID-19 pandemic) were used. The findings from the document "Analysis and Guidelines for the Digitalisation of the Education System" conducted by UNICEF, which was completed in February 2021, were also used. National strategies, the EU Digital Education Action Plan 2021–2027, the EU Digital Strategy, and the Western Balkans Economic and Investment Plan were used to develop the strategy.

This study conducted in Montenegro in 2021 argued that the digitalisation of the educational system is not a one-way street or a quickly achievable goal. This complexity was seen in the components, which involve not only the introduction of digital technologies into the teaching process but also the digitalisation of all the processes in the education system, the development of electronic services for students, teachers, and parents, data exchange with other institutions with the aim of modernisation and more efficient work when it comes to the administrative processes in all departments, and inclusion (ensuring that the poor and needy are not left out). Also, this complexity was seen in the number of institutions that had to work together to achieve such a goal. The necessity of a strategy was not questionable. Their digitalisation strategy has three strategic goals, with each goal having objectives, and the objectives are measured with a set of indicators. Table 2 shows a summary of the goals, objectives, and some indicators.

Table 2

Strategic goals, objectives, and some indicators in the digitalisation strategy of Montenegro

Strategic goal	Objectives	Indicators
G1 Improvement of Educational Information System	Improvement of legislation	Development of rulebook on data storage, backup, appointments, …
	Improving the hardware infrastructure	Procurement of new equipment. Maintenance of hardware infrastructure, …
	Development and upgrading of software components	Creation of new modules. Upgrading of existing software, …
	Improving the processing, use, accuracy and reliability of data	Number of institutions familiar with an EMIS, Promotion of EMIS, …
	Introducing interoperability and development of e-services	Number of new processes digitalised, Identification of out of school children, …
	Improving HR structure	Number of implemented training activities. Increase in the number of teachers in the IT sector, …
G2 Development and Upgrading of the Digital Ecosystem	Establishment of a mechanism for planning and development	Development of a plan for an increase in the knowledge of teachers who teach computer science in primary/secondary schools, Development of a framework for developing digital competencies of teachers, …
	Improvement of legislation	Number of amended legal acts. Number of newly created legal acts, …

	Improvement of IT infrastructure in educational institutions	Computer/student ratio Installation of connectivity facilities, …
	Development of digital educational content	Number of digital contents on special topics, Number of digital contents for children with special needs, Number of textbooks supplemented with digital content, …
	Establishment of a platform for independent learning	Percentage of children using the platform. Percentage of educational personnels using the platform, …
	Improving online collaboration in all institutions	Percentage of personnel using online collaboration tools Percentage of students using online collaboration tools, …
G3 Development and Improvement of Digital skills and competencies	Raising the digital skills and competencies of employees in educational institutions	Teacher training for acquiring digital competencies Teacher training for the application of ICT in working with children with special educational needs, …
	Raising the level of digital skills and competencies of students, with a special focus on children and young people from vulnerable groups	Percentage of primary and secondary schools that have clubs/groups in the field of ICT Organisation of thematic camps and competitions in the field of ICT, …
	Improvement in safe use of technology	Number of students involved in cybersecurity activities. Creating and accrediting a general cybersecurity training programme for all employees in educational institutions, …
	Improvement of digital skills and competencies and use of digital technology through promotional campaigns.	Number of promotional activities in the field of ICT. Percentage of schools involved in promotional activities in the field of ICT, …

An education policy review sponsored by the UN Response and Recovery Fund in partnership with UNESCO and the Ministry of Education and Science of Mongolia was conducted in Mongolia in 2021. This review identified a set of policy issues and recommendations in different areas that are important in ensuring the development and sustainability of ICT in education. The key areas, policy issues, and recommendations are presented in Table 3.

Table 3

Key areas, policy issues and recommendations considered in Mongolia

Area	Policy Issue	Recommendation
ICT infrastructure	Ensure access to ICT devices	Ensure families have computers mostly the poor, and partner with them to buy the computers.
	Sustainability of ICT Infrastructure	Prepare a maintenance, sustainability and e-waste management plan.
School level	Develop ICT culture in schools	Train school administrators on ICT leadership and require them to develop a school ICT plan within the year of their training
Teachers	Need to mainstream ICT competency standards for teachers	Adjust pre-service teacher education curriculum and review professional development courses so as to integrate ICT competencies for teachers.
	Limited opportunities for teachers to find advanced training on ICT	Encourage the private sector, including international training providers, to deliver on site or online training that is consistent with the ICT Competency Standards for Teachers.
Curriculum and Content Development	Expected ICT skills of students remain unclear	Develop an ICT Competency Standards for Students. Also develop ICT standards for citizens, which should become the guide on what ICT skills should be taught in the Lifelong Learning units.
	Need to establish quality assurance for digital contents and resources	Produce a set of guidelines or standards that can guide teachers as they develop their digital materials and resources. Create a committee or unit to ensure these guidelines are met.
Lifelong learning	Lack of ICT resources in Lifelong Learning Centres	The Ministry of Education should consider allowing the private sector, civil society organisations and non-government organisations to operate Lifelong Learning Centres in some areas where the government cannot sustain a decent centre and offer lifelong learning programmes.
Education Sector Information System (ESIS)	Ensure that different information systems are linked	The MoES should develop an ESIS blueprint to unify the different information systems. The blueprint should include an estimation of the funding requirements and strategies to ensure sustainable funding in the years to come.

	Use ESIS for evidence-based education sector planning and management	Invest in the training of a small cadre of EMIS specialists, and educational planning and management specialists.
Financing	How to ensure sustainable funding for ICT in education?	Prepare a long-term financing plan and strategy for sustainable ICT in education and identify different funding sources and means of engaging the private sector to support ICT in education.
Governance of ICT in Education	Need to build institutional capacity and mechanism to execute activities and coordinate implementation	Establish a mechanism or unit to coordinate the implementation of ICT in education. This can be achieved by creating an independent agency to coordinate all ICT in education programmes for the country or by creating an ICT in education unit in the Ministry of Education.

This review also reveals the necessity for education systems to come out with ICT competency standards for teachers. The ICT training needs they propose are shown in Figure 7.

Figure 7

ICT training needs for teachers proposed by Ministry of Education and Science Mongolia

- prepare multimedia training materials;
- develop innovative methodologies using ICTs/project based learning and collaborative learning using computers, etc. use ICTs for student assessment;
- integrate ICTs in a particular area of research;
- use social media for teaching and learning;
- teach ICT as a subject;
- present online training with online teachers and learners using ICTs;
- develop electronic tutorials and animations;
- prepare training materials;
- work freely on computer programs;
- use ICTs for extracurricular activities including social networking in teaching and learning;
- access information from educational sites; and
- use easy to use software for class data processing.

Source: MoES Mongolia (2021)

A qualitative study conducted by the Ministry of Education in Rwanda led to a masterplan for information and communication technology in education for the Republic in 2015. Data was collected through consultation with different stakeholders in the education sector. The purpose of the masterplan was to provide a roadmap for coordinated prioritisation, investment, and implementation of ICT in education in Rwanda. In this plan, the Ministry of Education in Rwanda announces their intention to roll out broadband across the country, partner with an investor to set up an ICT device assembly plant in Rwanda, and implement a new curriculum that provides the opportunity to deeply integrate technology, rethink the approach to teaching and learning, and revolutionise teaching materials by switching from print to digital learning materials. This masterplan identified seven important pillars in which to invest. These pillars and their main objective are provided in Table 4.

Table 4

Pillars of the masterplan of MoE Rwanda (2015) and their main objective

Pillar	Main objective
Policies	Develop clear and effective policies that encourage and empower teachers and students to use ICT as an integral part of the education process.
Leadership development	Train leaders that help, lead, support, and encourage the regular use of ICT in the classroom.
ICT infrastructure	Ensure scalable ICT infrastructure, availability of broadband and user support.
Curriculum and Content	Develop and acquire digital content that is aligned to the curriculum and a content distribution platform.
Teacher preparation and development	Policy program to equip teachers with tools and skills to integrate ICT in the teaching and learning process.
Higher education, research and innovation	Increase access to higher education, drive research and innovation.
Resourcing and Implementation	Source investment and support from government, private sector, donors, NGOs, and local communities.

This study also reveals that Rwanda planned to take care of learners with disabilities by acquiring appropriate assistive technologies and reduce the digital divide by providing computers to teachers and students. The Ministry of Education in Rwanda insists on the indispensable role played by teachers and calls them the key to the successful integration of

ICT in education. They also insist that the successful implementation of the masterplan will depend on the following:

- effective policies required to drive systematic, large-scale transformation from driving investments in ICT to ensuring accountability of programmes;
- single implementation framework to coordinate the large investment to be made and manage change. They planned to set up a dedicated unit responsible for driving, monitoring, coordinating, and managing the masterplan;
- concerted communication plan to create awareness and sensitise schools, students, parents, the community, and other stakeholders of the masterplan.

A qualitative study published in 2022 by UNESCO that prescribes guidelines for ICT in education policies and masterplans was conducted by UNESCO under the coordination of Fengchun Miao in 2022. Data for this publication by UNESCO was collected from their practical experiences to guide more than 60 Member States to support the development and implementation of national ICT in education policies. Also, experts were consulted for this study, and they provided valuable information. UNESCO has always been a convener and developer of international standard instruments in the field of ICT in education. This publication aimed to guide policymakers on how best to integrate humanistic principles in national policy documents with legally binding effects, develop a holistic and needs-driven understanding of ICT in education, provide a guiding framework to steer the use of ICT towards addressing the key challenges of achieving SDG 4, and steer the digital transformation of their education and training systems towards the enhancement of human competencies for all citizens and towards increasingly sustainable societies. More precisely, it aims to introduce a roadmap to guide the development of ICT in education masterplans from conception to implementation. The guidelines are supported by examples of how national ICT in education policies should address key issues relating to curricula, assessment, digital learning resources, and the development of Educational Management Information Systems (EMIS).

This study, conducted by UNESCO under the coordination of Miao, posits that a common understanding of what entails ICT in education between interconnected institutions and the perception of it as a long-term process is capital. They affirm that ICT in education policies should be implemented as a set of procedures or protocols for making decisions on legislative arrangements and budget planning and to guide concerted actions across the entire society, which stretches across the sectors of education, ICT, funding, and other stakeholders in learning communities.

This study also revealed different ways of promoting digital inclusion and exploiting digital innovation, a guiding framework for planning digital transformation in education, guiding principles for developing digital transformation policies and masterplans, the necessity of understanding the global governance architecture and its implications for ICT in education policies, a policy and masterplan development roadmap, specific strategies to develop masterplans based on the educational sector (school education, higher education, non-formal education, etc.), and the necessity of continuous improvement. They also suggest that masterplans can be done per component, such as a masterplan for EMIS, a masterplan for digital resources, a masterplan for sub-sectors, etc.

Miao et al. (2022) propose strategies to deal with each sub-sector of education and prescribe that the vision for school education should be that students and teachers should have access to digital devices (e.g., computers, mobile devices, tablets, printers, and robots) as well as digital tools (e.g., word processors, browsers, and AI-driven tools), materials (e.g., texts, video and audio recordings, and virtual objects), and services (e.g., search engines and social networks). They should be able to use these to achieve their learning and teaching goals, including implementing new pedagogies that make schools more inclusive and relevant to community needs and empower students to become active global citizens. They also consider the following as key challenges when developing a masterplan for school education:

- absence in the educational community of a shared vision of the use of ICT, which includes not only access to digital devices, instruments, and materials but also changing the school culture;
- lack of access for students and teachers to proper digital devices (including mobile devices) for pedagogical purposes;
- lack of, or limited access to, high-quality (fast and reliable) internet connectivity;
- insufficient professional development for teachers in a rapidly changing digital environment. According to Miao et al. (2022), this is the biggest barrier to ICT-pedagogy integration. They think that the huge amount of investment dedicated to providing ICT infrastructure in schools is wasted without a well-prepared workforce.
- inability of many schools to use technology in ways that can improve learning outcomes and scale up the adoption of effective approaches to teaching.

Miao et al. (2022) thus posit that ICT will only be able to support, enrich, and transform school education if its deployment is systemic and starts with clear pedagogical needs. Miao et al.

(2022) also propose factors to enhance digital transformation in school education and lines of action. These factors and lines of action are provided in Table 5.

Table 5

Factors to enhance school education and lines of action proposed by Miao et al. (2022).

Factor	Line of action
Provision of digital infrastructure to schools	Build a database and analyse the state of the digital infrastructure available for school. Conduct a needs analysis of the digital infrastructure for schools. Ensure there is adequate technical support. Determine implementation and its components.
Developing teachers' ICT competencies and support their continuous professional development	Streamline strategies for pre- and in-service teacher training and ongoing support. Establish standards for teachers' ICT competencies. Support the development of professional networks and communities of practice. Incentivize teachers' effective pedagogical use of ICT.
Leveraging ICT to improve the quality of teaching and learning	Build the vision of harnessing ICT in education starting with the pedagogical needs. Leverage ICT to improve the quality of learning in core subject area. Leverage ICT to transform the education process and improve learning outcomes. Include a pilot stage of the project to test the proposed innovations and mechanisms.

This study also mentioned issues to consider that are independent of the sub-sector: students' cultural norms and proper behaviour in the digital environment, and gender equality. They provide seven elements of any digital transformation project, which are: vision, learning, culture, technology, professional development, funding and sustainability, and community engagement.

Miao et al. (2022) also proposed a framework for designing a masterplan for digital resources. This study expresses the importance of digital content and national platforms to support distance learning in order to ensure the continuation or right to education even during instances of crises. They think that the vision for digital resources is that all students and teachers should have universal access to quality digital learning resources. These resources should be customised to ensure accessibility according to users' needs and local cultural and educational contexts, and they should be monitored through recognised and fit-for-purpose quality-assurance mechanisms. These resources should also be easy to administer, share, and find. They can be reused and regularly evaluated, updated, and adapted to take advantage of new

pedagogical and technological advancements. They also affirm the following as challenges linked to the development of digital resources:

- financial resources are needed to develop and regularly update curriculum-aligned digital learning resources that cover all subject areas and all grade levels;
- there is a lack of high-quality OER that is relevant to the local curriculum;
- localised materials with different language options are scarce;
- there are often delays in the provision of learning materials to end users;
- accessing quality learning materials in remote regions can be difficult, for example, in schools where there are no English or science teachers;
- teachers and students must be motivated to familiarise themselves with digital learning resources for teaching and learning;
- there is always a need to update digital resources in order to keep pace with rapidly developing technologies and changes to the curriculum.

Miao et al. (2022) also proposed elements to consider when preparing, disseminating, and using digital learning resources and lines of action. Some of these elements and lines of action are provided in Table 6.

Table 6

Elements to consider when preparing and using digital resources and lines of action proposed by Miao et al. (2022)

Factor	Line of action
Developing digital learning resources for all subject areas and grade levels	Carry out a needs assessment for all grade levels and school types. Select appropriate ways to secure sufficient funding resources for the production and provision of digital learning resources based on the capacity of the country. Enable the relevance of digital learning resources for learners from economic, cultural, and linguistic minority groups and ensure access for learners with disabilities. Adjust quality-assurance mechanisms for learning content to cover digital learning resources. Institutionalize quality control of resource development and establish guidelines and standards for them.
Embedding pedagogical principles	Ensure that age-appropriate pedagogical principles are applied when designing and developing digital learning resources. When forming resource development teams, include not only project managers, specialists in technological design and production, and

in digital learning resources	programmers, but also specialists in quality assurance, peer reviewers, librarians, instructional designers, specialists in media accessibility, and if possible, international experts
	Provide incentives for teachers to curate and create high-quality digital resources and support them to use communities of practice and online platforms to share resources with their peers.
	Suggest learning routes or pedagogical methodologies for teachers to apply resources to structured units of digital courses. For digital resources to be included in teaching practices, encourage teacher agency and support teachers' remixing and innovative reuse.
Establishing national or institutional repositories to make digital learning resources accessible and searchable through various devices	Develop appropriate functions under the repositories or portals that allow teachers and learners to access the learning resources through various platforms or devices
	Develop learning resource repositories or databases of digital resources that allow access through unique identification and authentication, and support searching and retrieving, and the functionality to store and modify favourite resources.
	Select a content management system (CMS) that enables users to create, retrieve and edit information and knowledge in digital format such as images, graphics, animations, audio clips, and videos, in real time and on demand
	Review the various vendors in the market and validate them as qualified providers based on humanistic principles, inclusion and equity, and other relevant criteria
Training both pre- and in-service teachers on how to search, select, reuse, create and share digital resources	Conduct training to address different needs including, searching for resources on the internet, evaluating digital resources, integrating different types of resources into different pedagogical approaches, and developing innovative resources with emerging technologies. Motivate teachers by providing training incentives, certification, and flexible schedules. Support teachers' continuous professional development through various programmes such as seminars, workshops, meetings, and online communities of practice. Streamline pre-service and in-service teacher training programmes on the same topics.

They also proposed the following approaches for disseminating digital resources: offline devices with pre-loaded content, online digital textbooks, TV and satellites, and live streaming.

Miao et al. (2022) also proposed a guiding framework for masterplans for EMIS. EMIS collates conventional educational data (e.g., student numbers, gender ratios, attendance, and costs)

together with data automatically collected from ICT systems (e.g., LMS, VLEs, and adaptive technologies). Accordingly, they are crucial for the sound monitoring and evaluation of educational policymaking and management. EMIS has the potential to provide systematic and quality data in a well-structured enabling system and through user-friendly interfaces that facilitate the use of information to support decision-making and policy dialogues. In developing a masterplan for EMIS, the vision is that ICT-enhanced EMIS should be established and continuously updated to bring just-in-time provision of data to all sectors and all types of education. The capacities of EMIS managers and policymakers are strengthened as the system enables them to facilitate the collection, aggregation, analysis, and use of data to support monitoring, form policy, and improve practice. This enables continuous increases in effectiveness, efficiency, and equity when planning and managing educational policies. They also proposed the following as challenges that inhibit the development of an EMIS. These challenges include the following:

- data collection: lack of sound, systematic, up-to-date, and internationally comparable data for educational policy planning in developing countries. How to leverage emerging sources of data to support data collection in developing countries remains a challenge;
- data aggregation: in many educational systems, schools are the end points for data collection, which uses paper-based formats. These data are then reported to the provincial or central education authority. The extent to which this information is usable depends on whether it is effectively aggregated. Overall, countries lack the capabilities to aggregate data for analysis based on indicators and, more fundamentally, lack the capacity to develop well-defined indicators. In addition, in many countries, the efforts to implement EMIS are limited to ICT enhancements and/or data storage and maintenance, with insufficient attention paid to building the capacity of local EMIS-supporting teams to apply the system;
- data analysis: Countries also face challenges of data relevance, reliability, and accessibility. Specific challenges include the high cost of using paper-based EMIS to collect, process, and report data; multiple EMIS systems being deployed separately without interoperability; and the low level of responsiveness to emergencies and crises due to fragmented EMIS and the limited capacities of EMIS-supporting teams;
- data use: To achieve evidence-based policy planning, the challenge is not only data production but also the development of a reflective process through which policymakers use data to learn lessons from multiple perspectives. In addition, policymakers need to

be aware that the data available are always only partial; there can be many important variables that are not or cannot be included. Accordingly, the outcomes of the data have to be carefully and critically interpreted.

Miao et al. (2022) also proposed factors that promote the proper planning, development, and use of an EMIS and lines of action to achieve them. Some of these factors and lines of action are provided in Table 7.

Table 7

Factors and lines of action for proper functioning of an EMIS proposed by Miao et al. (2022)

Factor	Line of action
Optimising connectivity, processing, and human capacities to support sound data collection for EMIS	Build and strengthen school-level EMIS-supporting teams composed of school principals, teachers or administrative officers who usually complete questionnaires or enter data in administrative databases.
	Connect all target schools or educational institutions and ensure that institutional-level data are collected and recorded in EMIS with sound efficiency and quality.
	Exploit emerging technologies to improve the cost-effectiveness, accuracy, security, and efficiency of data collection, including taking advantage of the spread of mobile broadband access in developing countries to record data in EMIS using mobile applications.
	Streamline and optimise the information management flow so that data recording in EMIS can be engineered seamlessly at central, regional, city and school levels.
	Train principals and teachers to use EMIS and interpret their outputs.
Develop indicators and enhance data aggregation and analysis	Build national repositories to host and manage educational data that are collected from decentralized sources. Modules for the integrated EMIS repositories should be developed and tailored according to the needs of all target audiences.
	Develop and keep improving the relevance of key indicators and use them to ensure data are analysable.
	Collect and integrate data through different sources, such as administrative data (including from EMIS), sample surveys, structured tests, and big-data sources.
	Incentivize teachers' effective pedagogical use of ICT

Strengthen technological and human capacities in using data effectively for policymaking, teaching and learning	Develop or strengthen the technological capacities of the national or local central EMIS platform to support the data analysis and visualization, report generation, and communication. Assess the ICT in education readiness in the country and study the feasibility based on the public funds available. Then, make a decision on whether the blockchain technology can be adopted for the upgrading of the national EMIS Develop strategies for building capacities with an aim of creating the awareness and skills necessary for the adoption and institutionalization of EMIS at all levels. Develop professional training to enable policymakers, principals, teachers, and parents to carefully interpret the EMIS outputs alongside other contextual information.

Miao et al. (2022) also think that measures should be taken to deal with issues related to privacy and the ethical use of data, sources of data, and learning analytics. They also proposed that EMIS can be centralised at the national level or decentralised as per stakeholder.

The study also provided key factors that policymakers need to understand and address to ensure a humanistic, successful, and sustainable digital transformation in education. These factors are:

- the use of ICT in education should be guided by humanistic principles, serve humans, and enhance their competencies. The potential negative impact of ICT on student wellbeing should be avoided; and policies must balance the educational benefits with the environmental costs;
- the priority should be expanding access to educational opportunities, advancing inclusion, and supporting lifelong learning;
- ICT on its own will not provide the solution to a country's educational problems, so challenges within the existing systems should first be addressed, with or without the help of ICT;
- teaching and learning should not be driven by technology; pedagogy that enhances the quality of learning by leveraging the affordances of ICT should be developed, while the automation of poor pedagogic practices should be avoided;
- training to enable teachers to take full but cautious advantage of ICT is essential;
- the development of ICT in education policies is a long-term process, and the policy and masterplan should be produced as part of an integrated education portfolio.

A qualitative study on digital transformation in education that focused on critical components for leaders of system change was conducted by McCarthy in 2023. Data was collected through observation, source documents, and a literature review. Thematic analysis was undertaken to identify and interpret patterns of terms (themes). This systematic process produced a clear identification of key digital transformation framework (DTF) components to guide leaders embarking on change. Twenty (20) organisations (9 consulting organisations, 6 technology companies working in education, and 5 organisations influencing educational policy) and 7 Ministries of Education (MoE) in developing and developed countries that embarked on the digital transformation process were analysed. Some of the pertinent themes and subthemes detected in the study are presented in Table 8.

Table 8

Themes and subthemes pertinent to digital transformation by McCarthy et al. (2023)

Theme	Subtheme
Leadership	Culture Strategic planning and sustainability Policy, Risk and Compliance, and Governance Measurement
People	Partnerships and Community Engagement Attributes and Skills Talent Journey and Wellbeing Insights and Performance
Technology	Connected and Secure Ecosystems Operations and IT Management: Personalised and Intelligent Platform

A qualitative study was conducted by Brunetti et al. in 2019 in the Tyrol-Veneto macroregion with the aim of proposing adequate strategies that companies, public administrators, and organisations in the education industry can undertake to successfully face the challenges of digital transformation in a regional innovation system. Data was collected through an interview with 60 stakeholders. The data was analysed through content analysis and text mining analysis. The results revealed that digital transformation requires a multifaceted set of strategic actions falling into three main pillars:

- culture and skills, which included three strategic fields of action: digital education, talents, and digital culture.
- infrastructures and technologies, which pointed out the need for information, interaction, and artificial intelligence as key strategic fields of action;

- ecosystems, which highlighted the importance of investing in medium- to long-term visions, partnerships, and life quality.

The study also suggests that education organisations should provide digital skills to several cohorts of both students and workers. The policy implications of the study call for the creation of new occasions of cooperation among stakeholders by fostering "table talks" as strategic and policy actions and by making more financial resources available to encourage the digital transformation processes. Brunetti et al. (2019) conclude this study by affirming that standalone interventions are insufficient to tackle digital transformation from a systemic perspective.

A qualitative study with data collected from books, national journals, international journals, published government reports, and other websites was conducted in 2019 by Sheetal and Menaka in India on the digitalisation of education in the 21st century. This study was investigating the pros and cons of digitalised education in India, its current state, and efforts made by the government. This study revealed that the major advantages of digitalising education are an enhancement of learners' ability to manipulate technology, easy sharing of knowledge, exposure of learners to learning applications, and the possibility of following a lesson many times. They also highlight the following as disadvantages: issues related to financial inclusion and building friendship. They further mention the projects and programmes launched by the government to support the digitalisation of education in India, such as the creation of an electronic platform, the introduction of education channels, and the creation of a national digital library.

A qualitative study was conducted by Twagilimana and Barbutiu in 2017 on the current situation, challenges, and prospects of ICT education policy in Rwanda. Data for this study was collected from official reports and other studies conducted in Rwanda. The study revealed that ICT in education policies that are accompanied by coherent strategies and plans have been operational in Rwanda since the year 2000. They have developed seven different policies and plans from 2000 to 2015, with each having a specific goal towards the effective and sustainable integration of ICT in education. The goals ranged from improving infrastructure, connecting schools and training teachers, providing technical support, improving accessibility, quality, and relevance, promoting and supporting integration in educational practices, providing more educational opportunities and accessibilities, improving ICT penetration, and developing leadership and teacher's capacity. Twagilimana and Barbutiu (2017) also highlighted

challenges linked to the implementation of these policies and the integration of ICT in education. Some key challenges were:

- inadequate infrastructure (electricity coverage, internet connectivity, access to digital devices);
- absence of culture around the use of ICT;
- budget constraints;
- lack of expertise in project and programme management and poor coordination of initiatives;
- limited availability of digital content;
- insufficient monitoring and evaluation of ICT in education projects at the school level;
- lack of technical support;
- lack of analysis of the outcomes of partnerships;
- unclear standards in the educational sector;
- insufficient monitoring and evaluation of ICT in education projects and programmes.

Twagilimana and Barbutiu (2017) affirmed that a strong commitment on the part of different educational stakeholders to support ICT in education initiatives is a good sign of hope for a rapid transformation of the sector. They conclude by saying that there should be a shift in the design of ICT in education policies from a focus on technology itself to a focus on educational purposes that technology enables and supports.

A qualitative study titled ‘digitalisation of education: commodification hidden in terms of empowerment’ was conducted in Serbia by Armila et al. in 2022. Data was collected from educational authorities through a qualitative questionnaire and an interview. The study questions the belief that equality is achievable via digital structures and patterns of schooling. Data collected show that digitalisation per se cannot be a solution; for example, poverty hierarchies within the population are tough and should be solved first. It shows that an emphasis on digitalisation can sometimes strengthen the prevailing educational gaps between different sociocultural population groups if digitalism is not paying attention to human and societal conditions. They argue that if digital imaginaries are blindly followed, they benefit those who are already privileged. They also warn against the capitalism of producers of digital technologies and claim that capitalism is not a societal and economic order that leans on the politics of equality and opportunities for ‘all’. Further, it is not interested in the kind of humanistic philosophy that is often seen as the basis for educational ethics.

A mixed study conducted as part of the MIT Sloan Management Review research initiative in collaboration with and sponsored by Deloitte Digital on achieving digital maturity was coordinated by Kane in 2017. Data was collected from 3500 managers and executives, and 15 executives and thought leaders were interviewed. Data analysis from this survey revealed five key practices of companies that are developing into more mature digital organisations. Their practices, which may offer valuable lessons for organisations that want to improve their own digital efforts, include the following:

- implementing systemic changes in how they organise and develop workforces, spur workplace innovation, and cultivate digitally minded cultures and experiences;
- playing the long game: their strategic planning horizons are consistently longer than those of less digitally mature organisations;
- scaling small digital experiments into enterprise-wide initiatives that have business impact;
- becoming talent magnets: digitally maturing organisations typically understand the need for and place a premium on attracting and developing digital talents;
- securing leaders with the vision necessary to lead a digital strategy and a willingness to commit resources to achieve this vision.

Another mixed study conducted as part of the MIT Sloan Management Review research initiative in collaboration with Deloitte Digital on achieving digital maturity was coordinated by Kane in 2019. Data was collected from 4800 managers and executives, and 14 executives and thought leaders were interviewed. The following are key findings of this study:

- digitally maturing companies innovate at a higher rate than their less mature counterparts;
- digital maturing companies use cross-functional teams;
- members of digitally maturing companies believe their organisations have the power to adapt to changes wrought by digital disruption and expand their capabilities.

A four-year mixed study conducted by Kane in collaboration with MIT Sloan Management Review research and Deloitte on how traditional companies can keep up and adapt in today's digital world and the organisational changes required to harness the power of technology. This study led to the book entitled 'The Technology Fallacy: How People are the Real Key to Digital Transformation'. Data was collected from a survey of executives from 157 countries, with one-third of the executives coming from the United States. This survey drew more than 16000 responses, or approximately 4000 responses per year. Data was also collected through

interviews with executives and thought leaders that are doing groundwork on digital transformation. This study revealed that companies must address three business issues if they are to manage digital transformation effectively. These issues include navigating digital disruption, rethinking leadership and talent, and becoming a digital organisation. The writers concluded that culture, as it turns out, can advance or inhibit digital transformation. They add that if companies can lay the groundwork by building a culture that is more adaptable to change, then implementing new technology and business processes can proceed more smoothly.

A mixed study was conducted by Cortellazzo et al. in 2019 on the role of leadership in a digitalised world. Data was collected from the Scopus database with a sample of 790 articles. A qualitative selection of articles was also done based on criteria such as the number of citations, the year of publication, and alignment with the topic. The findings revealed that leaders are key actors in the development of a digital culture: they need to create relationships with multiple and scattered stakeholders and focus on enabling collaborative processes in complex settings while attending to pressing ethical concerns.

CHAPTER 3: METHODOLOGY

Research Design

Research design is the framework or road map (guide) that researchers use for the planning, implementation, and analysis of a research study. It is a systematic plan of 'what' is to be done, 'how' it will be done, 'how' the data will be collected and analysed, 'how' the instruments will be used, and the 'intended means' for analysing the data and its presentation (Li et al., 2018). According to Cohen et al. (2018), research design is the plan for, and foundations of, approaching, operationalizing, and investigating the research problem or issue; setting out the approach, theory or theories, and methodology or methodologies to be employed; the types of data required, how they will be collected (instrumentation), and from whom (the population and/or sample); how the data will be analysed, interpreted, and reported; the warrants to be adduced to defend the conclusions drawn and the degree of trust that can be placed in the validity and reliability of each element of the research; and the sequence of the research.

This study is exploratory and descriptive in nature. It follows a qualitative approach, and there are many research designs that suit qualitative studies. Li et al. (2018) outline the following as prominent research designs for qualitative studies: Action Research, Case studies, Ethnographic studies, Grounded Theory, Historical studies, and Phenomenological studies. This study aims at exploring and describing selected digitalisation efforts performed by the Ministry of Secondary Education in Cameroon, identifying issues related to these efforts, and proposing recommendations to curb these issues. Due to its descriptive and exploratory nature, we are going to use a Case study research design.

According to Li et al. (2018), a case study explores and analyses the life or functioning of a social or economic unit, such as a person, a family, a place, an event, a phenomenon, a community, an institution, a firm, an industry, or other type of subject of analysis, in order to extrapolate key themes and results that help predict future trends and illuminate previously hidden issues that can be applied to practice. This definition provided by Li et al. (2018) and the features of Case study provided by Cohen et al. (2018) support the use of a Case study as a research design for this study. This research will consider the following instances of the digitalisation of secondary education: the programme for equipping schools with Multimedia Resource Centres, the development of a web application to manage the human resources of MINESEC, and the creation of a Distance Education centre.

Area of study

The research area for this study is the Ministry of Secondary Education in Cameroon. It will include central services such as the inspectorate in charge of computer science and deconcentrated services such as Regional Delegations and the Distance Education centre. Before 2005, secondary education was managed as a component of the Ministry of National Education. Decree No. 2005/139 of April 25th, 2005, created the entity termed MINESEC as an independent unit and placed it under the general supervision of the Minister in Charge of Secondary Education. MINESEC, since its creation in 2005, has had three ministers, as shown in Table 9.

Table 9

Successive Ministers of MINESEC

Name	Period
Pr. Pauline Nalova Lyonga Egbe	2nd of March 2018 to date
Jean Ernest Ngallé Bibéhè	2nd of October 2015 to 1st of March 2018
Louis Bapès Bapès	9th of December 2004 to 1st of October 2015

MINESEC is currently headed by Pr. Pauline Nalova Lyonga Egbe, who has a track record of promoting digitalisation in the institutions she has headed.

MINESEC is located in the Mfoundi division of the Centre region. The Mfoundi division has seven subdivisions, and MINESEC is in the subdivision called Yaounde III. MINESEC shares boundaries with the Ministry of Basic Education and the Ministry of Public Service. Figure 8 shows the localisation map of MINESEC, while Figure 9 shows a cross-section of the building of MINESEC.

Figure 8

Localisation map of MINESEC

Source: Google Map, 2023

Figure 9

Building of MINESEC

Source: adapted from Google Map, 2023.

The Inspectorate in charge of Computer science is found at the fifth floor of the MINESEC building. The inspectorate occupies 3 offices at this floor which are labelled 501, 503 and 514. The office labelled 501 is that of the Inspector coordinator General currently occupied by Mr. Fomboh Julius Fombutu. The office 503 is that of the national inspectors and the head of department for ICT while 514 is that of the other national inspectors and head of department for computer science.

The recent service added to the Ministry of Secondary Education is the Distance Education Centre. It was created in 2020 as a response to the COVID 19 pandemic and is located directly opposite to the secondary gate of High teachers' Training College (HTTC) Yaounde and shares boundaries with the Government Bilingual Technical High School Yaounde. Figure 10 shows a cross section of the building of the Distance Education Centre.

Figure 10

Distance Education Centre

Source: Google Map, 2023

Since its creation, the Distance Education Centre has been headed by Mr. Jean Pierre Adjaba, Inspector Coordinator General of Science (ICG/Science). It is hosting recording studios where video lessons are recorded and edited, then placed online, and an e-counselling helpline where learners and parents have access to a toll-free number (1530) and can talk to a counsellor. The toll-free number can entertain 10 conversations at the same time.

Population of study

Population in research refers to the units (people, cases, and pieces of data) that researchers wish to investigate and study (Li et al., 2018). The population of the study is the structures and top officials in the central and deconcentrated services in the Ministry of Secondary Education and experts in techno-pedagogy of higher institutions related to MINESEC, such as the Higher Teacher's Training College Yaounde.

Sampling and Sample size

Sampling is the act of selecting the population that will be used for analysis in the study (Li et al., 2018). Cohen et al. (2018) support the necessity of sampling by claiming that factors such as expense, time, and accessibility frequently prevent researchers from gaining information from the whole population. Therefore, they often need to be able to obtain data from a smaller group or subset of the total population in such a way that the knowledge gained is representative of the total population under study.

This research follows a qualitative approach, and the sampling techniques used for such a study are non-probabilistic in nature (Cohen et al., 2018; Li et al., 2018). Cohen et al. (2018) question the importance of identifying a population or sample in qualitative studies since their samples are generally non-representative of the population. They further argue that in such cases, it is perhaps unwise to talk about a 'sample', and more fitting to talk about a group or individuals. How far they are representative of a wider population or group is irrelevant.

This research will use a purposive sampling technique, which, according to Cohen et al. (2018), is a sampling technique where researchers handpick the cases to be included in the sample on the basis of their judgement of their typicality or possession of the particular characteristic(s) being sought. They assemble the sample to meet their specific needs. Li et al. (2018) see it as a technique that is applied when researchers believe that some subjects are more suitable (fit) for the research compared to other individuals.

The sampling frame is made up of experts and active actors in the process of digitalisation of education, or secondary education. These experts and active actors will be taken from HTTCs,

central services of MINESEC, and deconcentrated services of MINESEC, more precisely regional delegations of secondary education. Most of the sample will be taken from the centre region since this part of the country is easily accessible to the researcher.

The sample is made up of experts who can provide valuable information in the different cases considered. These experts are chosen at the strategic, tactical, and operational levels of management. We decided to work with 3 experts at the strategic level, 2 experts at the tactical level, and 2 actors at the operational level. Table 10 summarises the sample and sample size for each level.

Table 10

Number of people interviewed at each level of management

Level of Management	Sample size
Strategic	3
Tactical	2
Operational	2
Total	**7**

Instrumentation

Instrumentation refers to the methods of data collection in research (Cohen et al., 2018). There are methods that are appropriate for quantitative, qualitative, and mixed approaches. Qualitative approaches make use of methods such as interviews, observations, field notes, documents, artefacts, archival records, and more (Li et al., 2018; Cohen et al., 2018). This study used the following data collection methods: interview, observation, document analysis, and study of artefacts.

The type of interview used was a blend between the interview guide approach and standardised open-ended interviews mentioned in Cohen et al. (2018) or a semi-structured interview as mentioned in Li et al. (2018). The observation used was direct, partially concealed, and participant-based in most of the case studies. These dimensions of observation are mentioned by Cooper and Schindler (2001), as cited in Cohen et al. (2018). Looking at it from the perspective of Li et al. (2018), the observation method used was direct, covert, and unstructured. The documents to be analysed were from leading organisations in the digitalisation of education, such as UNESCO.

Validity of Instrument

Validity is a demonstration that a particular instrument in fact measures what it intends (Li et al., 2018), purports, or claims to measure, and that an account accurately represents 'those features that it is intended to describe, explain, or theorise' (Winter, 2000, as cited in Cohen et al., 2018). Ary *et al*. (2002), as cited in Cohen et al. (2018), also define data validity as the extent to which interpretations of data are warranted by the theories and evidence used. They also note that validity concerns not only the extent to which an instrument measures what it claims to measure but also the meaning and interpretation of the results of the data collection and instrumentation. Validity should be fit for purpose (Cohen et al., 2018). Validity takes many forms. For example, in qualitative data, validity might be addressed through the honesty, depth, authenticity, richness, trustworthiness, dependability, credibility, and scope of the data achieved, the participants approached, the extent of triangulation, and the disinterestedness or objectivity of the researcher (Winter, 2000; Flick, 2009; as cited in Cohen et al., 2018).

This research follows a qualitative approach and will apply validity criteria that are coherent with the approach. Lincoln and Guba (1985) and Ary *et al*. (2002), as cited in Cohen et al. (2018), suggest that key criteria of validity in qualitative research are credibility, transferability, dependability, and confirmability. Onwuegbuzie and Leech (2006b) and Teusner (2016), as cited in Cohen et al. (2018), set out many steps that researchers can take to ensure validity in qualitative research. Most of these steps were applied to ensure the validity of this research.

The validity of this study is first sustained by the time spent by the researcher on the field, mostly at the Distance Education Centre and the Inspectorate of Computer Science, who is in charge of supervising the Multimedia Resource Centre programme, to objectively observe factors that are influencing the digitalisation of secondary education and obtain data on actions taken by key actors involved in the digitalisation of secondary education. Pitfalls such as changes in the behaviour of participants were minimised since the researcher was partially concealed during their time spent in these institutions. Besides, the experts and actors concerned with digitalisation that were interviewed were chosen because they have a broad view of what is happening in other regions of Cameroon. Actors from other regions were interviewed to cover a wide area, get different opinions from different contexts, and also corroborate information from some experts.

Also, the validity of the research can be ascertained based on the types of respondents chosen and the documents and field notes perused. Documents such as decrees, circulars, masterplans,

white papers, reports, guiding documents, and instructions from authoritative sources like UNESCO, OECD, WEF, the Ministry of Education of other countries, the Presidency of the Republic of Cameroon, MINPOSTEL, MINESEC, and regional delegations were used to obtain data and identify best practices. Besides, the instruments for data collection were conceived using guidelines prescribed by Cohen et al. (2018), Li et al. (2018), and with help from my supervisor, who is an expert in data collection and analysis.

Moreover, the wealth of literature reviewed in the digitalisation of education and policies related to the digitalisation of education, as well as the literature reviewed in the digitalisation of the industry and its best practices, also adds to the validity of this research. Besides that, the theories used supported the findings and recommendations made to ensure a successful and sustainable digitalisation of secondary education.

Furthermore, experts in the domain of digitalisation of education with hands-on experience were consulted and interviewed on the current practices of digitalisation in secondary education. Adding to this, prescriptive documents from UNESCO on how to integrate ICT in education and EMIS were reviewed and compared with the current practices and opinions of experts in the digitalisation of education that were contacted.

Finally, bias was reduced by focusing on all ideas that came up during observation, recording the data immediately after the observation, and allowing only the collected data to decide on the strength or weakness of a given opinion. Besides that, during interviews, participants were given enough time to relax and answer the questions.

Reliability of Instrument

Reliability is essentially an umbrella term for dependability, consistency, and replicability over time, over instruments, and over groups of respondents (Cohen et al., 2018). The reliability of the study was supported by the fact that the researcher spent a huge amount of time in key areas of the study and noticed over time that the factors affecting the digitalisation of secondary education did not change. Also, the problems and potential causes linked to the production of digital resources in the Distance Education Centre were almost the same for all the inspectorates, implying that another researcher would have come out with the same results. Moreover, the issues and recommendations expressed by the respondents were not ambiguous and were in phase with the issues found in the large set of literature linked to digitalisation and the digitalisation of education.

Reliability was also guaranteed by ensuring participants that the results would be presented anonymously and that there would be no intrusion. Even though an unstructured interview with mostly open-ended questions was used, respondents in the same category were asked the same questions using the same words and in the same order. Also, responses for each category were coded in the same way. Moreover, best practices when preparing interview questions were applied, ensuring that responses are free from bias. Furthermore, data collected during observations was non-verbal, and participants did not know data was collected, making them act more naturally, thus reducing reactivity.

Method of data collection

The method of data collection refers to how the different instruments used to collect data were administered. Interviews were most often administered face-to-face. Very few interviews were administered through phone calls. Observation was direct and covert in most cases. It was unstructured at the beginning of the study, and as the study progressed, certain factors were considered more salient than others. Documents were collected from genuine sources and from the official websites of institutions on the internet.

Method of data analysis

Data analysis is a systematic search for meaning. It is a way to process qualitative data so that what has been learned can be communicated to others. Analysis means organising and interrogating data in ways that allow researchers to see patterns, identify themes, discover relationships, develop explanations, make interpretations, mount critiques, or generate theories. It often involves synthesis, evaluation, interpretation, categorization, hypothesising, comparison, and pattern finding (Hatch, 2002, as cited in Li et al., 2018). Data analysis highly depends on whether the data are quantitative or qualitative (Li et al., 2018; Cohen et al., 2018). According to Li et al. (2018), the prime objective of analysing data is to obtain usable and useful information. The analysis, regardless of whether the data are qualitative or quantitative, may assist the researcher in the following ways:

- describe and summarise the data;
- identify relationships between variables;
- compare variables;
- identify the difference between variables;
- forecast outcomes.

This study follows a qualitative approach, and most of the data generated was qualitative in nature. We thus used data analysis methods that are qualitative. Qualitative data analysis is a search for general statements about relationships among the categories of data (Marshall & Rossman, 2006, as cited in Li et al., 2018). The process of qualitative data analysis is typically inductive. Here the researcher reads, re-reads, reflects on, infers from, and interprets the raw data, transcripts, memoranda, etc. From this, without preconceptions or deductions from a pre-given framework (unlike, for example, experimental research or hypothesis testing), the researcher develops interpretations of the data and derives themes, concepts, theories, explanations, understandings, summaries, models, etc. that fairly and comprehensively explain the data or phenomenon (Cohen et al., 2018).

Wellington (2015) as cited in Cohen et al. (2018), suggests that qualitative data analysis includes: (a) dividing the data into 'units of meaning'; (b) classifying and grouping the units of meaning; (c) including new units of data into these groupings/categories; (d) searching for categories that are similar and/or which can be merged into a single category; (e) reviewing categories that contain large amounts of data to see if they can be split into smaller categories; (f) checking that the categories include all the data and are mutually exclusive (though some data may appear in more than one category); and (g) looking for linkages, contrasts and comparisons between the categories (constant comparison). He provides a seven-stage model for 'making sense of qualitative data':

- Stage 1: 'Immersion' in the data;
- Stage 2: 'Reflecting, standing back';
- Stage 3: 'Analysing' ('dividing up, taking apart, selecting and filtering, classifying, categorising')
- Stage 4: 'Synthesising and re-combining' data;
- Stage 5: 'Relating to other work, locating' data;
- Stage 6: 'Reflecting back (returning for more detail?)';
- Stage 7: 'Presenting, disseminating, and sharing' the findings.

Cohen et al. (2018) posit that there is no one single or correct way to analyse and present qualitative data; how one does it should abide by fitness for purpose. This study used the following data analysis methods: content and narrative analysis.

Content analysis is the process of summarising and reporting written data—the main contents of the data and their messages. Newby (2010), as cited in Cohen et al. (2018), reports three

kinds of content analysis: ‘conventional content analysis’ (from coding); ‘directed content analysis, wherein the coding structure derives from pre-existing theory or hypotheses; and ‘summative content analysis, wherein keywords are selected based on previous research or the researcher’s research interests. The kind of content analysis used in this study, according to Newby (2010), was summative. Content analysis is an unobtrusive technique; it is systematic and verifiable as the rules for analysis are explicit, transparent, and public. As the data are in a permanent form (texts), verification through re-analysis and replication is possible. Cohen et al. (2018) propose an eleven-step process to effectively carry out content analysis.

According to Cohen et al. (2018), narrative analysis, as with discourse analysis, encompasses different approaches that adopt differing ontological and epistemological positions on the social world and how it is construed and constructed. A narrative is a story with an individual perspective, written in the teller’s own voice, in which the teller controls what is released, when, and in what sequence. A narrative can also process and condense large amounts of data to provide a ‘more complex and complete picture of social life’. Narrative analysis creates unity out of disparate elements; it creates a story. Polkinghorne (1995), as cited in Cohen et al. (2018), distinguishes narrative analysis from the analysis of narratives. This study used narrative analysis, not an analysis of narratives.

Ethical Consideration

Ethical research concerns what researchers ought and ought not to do in their research and research behaviour (Cohen et al., 2018). Li et al. (2018) view ethics in research as a code of conduct or expected social norm of behaviour while conducting research. An ethical piece of research must demonstrate rigour and quality in the design, conduct, analysis, and reporting of the research. Ethical principles are not absolute, generally speaking (though some may maintain otherwise), but must be interpreted in the light of the research context and of other values at stake (Cohen et al., 2018; Li et al., 2018). Ethical practices relate more closely to the processes of data collection, reporting of research outcomes, and distribution of reports than any other phase of research.

During the interviews, the sources were informed that their information will be recorded in this research and were also asked to highlight information that they think is sensitive and may be easily tied to them so as to make sure the information published does not cause harm or discomfort in any way. Also, no third party was involved in the transcription of the collected data, thus ensuring the confidentiality of the data. Data containing personal information about

the sources for identification purposes were named in such a way that others could not easily deduce the meaning and were destroyed immediately after they were exploited by the researcher. Moreover, the sample frame for this study was not explicitly disclosed. Data collected during observation was coded so as to prevent identification of the individual.

Qualitative data analysis frequently concerns individual cases and unique instances and may involve personal and sensitive matters (Cohen et al., 2018). To ensure non-identifiability, anonymity, confidentiality, and privacy of individuals, the names or titles of sources of information are not mentioned. Also, information gathered during observations was presented from the researchers' point of view without citing individuals. Moreover, some of the data used in this study are from official websites and public administrative documents, indicating that it is meant to be consumed by anyone and will not cause harm if used or published in this study.

Synoptic table

Table 11 presents a summary of research questions and variables of this study.

Table 11

Synoptic table for this study

Research questions	Independent variable	Modalities	Dependent variable	Modalities	Analysis method
What are the key digitalisation efforts conducted by MINESEC? What are the major pain points of digitalisation in MINESEC? How can the difficulties faced by MINESEC be mitigated?	Policy	Distance Education Programme MINESEC DRH web application Multimedia Resource Centre Programme	Digitalisation	Digital Infrastructure (Digital devices, Connectivity, Power sources, software) Human resource development Educational management Information system	Content analysis Narrative analysis

CHAPTER 4: FINDINGS

The results of this study will be presented based on the different objectives and cases chosen.

Digitalisation efforts instituted by MINESEC and existing policies

In this section, we will present the different digitalisation efforts instituted by MINESEC in terms of public policies, programmes, projects, instructions, software implementation, etc.

Table 12 presents the main digitalisation efforts and the type of effort.

Digitalisation Endeavour	Type of effort
MRCs programme	Programme
Setting up IP-INFO	Project
Order No. 3745/D/63/ MINEDUC/CAB of 17/06/2003	Regulatory instruments
Decision No 24/05/MINESEC/CAB of January 17th, 2005	Regulatory instruments
Decision No 249/06/MINESEC/CAB of May 15th, 2006	Regulatory instruments
Creation of MINISEC website	Software
Creation of the TI series	Regulatory instruments
E-registration 2.0	Software
MINESECDRH.com	Software
Circular No.12/17/C/MINESEC/CAB of 9 August 2017	Regulatory instruments
Digital Payment of Fees	Software
Epim Exam	Software
GNI exam	Software
Spider 1 and Spider 2	Software
Distance Education Programme	Programme/software
Digital school map application	Software
Creation of a Computing Project Guide for schools	Regulatory instruments
Service Note 58/22/AR/MINESEC/SG/IP-INFO of January 7th, 2022	Regulatory instruments
Revision of teaching syllabus for computing subjects	Regulatory instruments
MINESEC CELCOM	Software
Creation of Email for central and Deconcentrated services	Project

Details of each digitalisation endeavour is presented in Appendix 6.

Other national efforts linked to education in general include the following:

- decree n°087/CAB/PM of June 27, 2005, creating a committee for the integration of ICTs in education in Cameroon (Josue, 2007);
- sensitisation campaigns to encourage pedagogic supervisors to mainstream OERs in the teaching and learning process.
- Considering digitalisation of teaching as the major theme for pedagogic days in the whole country for the academic year 2022-2023.

Other local efforts were made by Regional Delegates for Secondary Education to enforce the digitalisation of education in their regions for the academic year 2022-2023. For instance, the Delegate for the centre region designed a document that prescribes a minimal digitalisation kit she is expecting to see in every school and the number of kits each school must have based on their student populations. She also prescribed different models for implementing digitalisation of teaching in schools. The models are:

- defining dedicated halls where digitalisation should take place;
- using classrooms as environments where digital lessons are taught;
- a hybrid that involves the above two methods.

The Delegate for the Centre region also insisted on the appointment of a focal point for digitalisation in each school in the Centre region and defined an indicator for measuring the number of digitalised lessons taught by teachers each term and ensured that teachers are trained on the digitalisation of teaching and learning during events like pedagogic days. The Delegate then ensured that these instructions were respected by performing a tour in all the divisions of the centre region to ensure the effective implementation of the instructions given and learn best practices. Experience from the tour pushed her to launch a project on the revision of the minimal kits each school should have and prescribing a guideline on how to use lessons in the distance education platform in the classroom. The Delegate of the Centre region also made sure that during statutory days such as bilingualism day, guidance and counselling day, and world philosophy day, stands are created to vulgarise distance education resources and how to access the distance education platform. She instructed Divisional Delegates to designate a school to serve as a base or anchor point for Distance Education in their area of responsibility and monitor thoroughly the acquisition of digitalisation equipment by schools.

The Delegate of the Adamawa region focused on training. They trained principals and heads of inspectorates. The inspectorates then trained their teachers. The Delegate also signed a note to encourage principals to buy the necessary hardware needed to foster digitalisation. He also

requested weekly statistics on the use of digital resources. During live sessions of distance education lessons, the delegate enforced a strategy where links for live sessions are sent to all the forums of Divisional Delegations which are in turn sent to the principal's forum, and the principals then mobilise their teachers and students to attend the live lessons. There is also a contact person at the delegation that takes statistics on the schools connected and sends them to the Delegate. The Delegate also provided letters of congratulations to principals who were very active in the activities linked to the digitalisation of secondary education.

The Delegate of the South-west region also focused on training of school heads of public and private schools, inspectors and teachers. The Delegate bought computers for the delegation and charged each inspectorate to buy the necessary tools for digitalisation and also encouraged principals to do so. They Delegation of the South-west region worked in partnership with an NGO to ensure schools get computers at a very low cost. The Delegation also acted as a hub to distribute distance education resources to other schools that had difficulties accessing these resources. In a nutshell the Regional Delegates in all 10 regions focused on training, acquiring necessary hardware for effective digitalisation, and vulgarising the distance education programme.

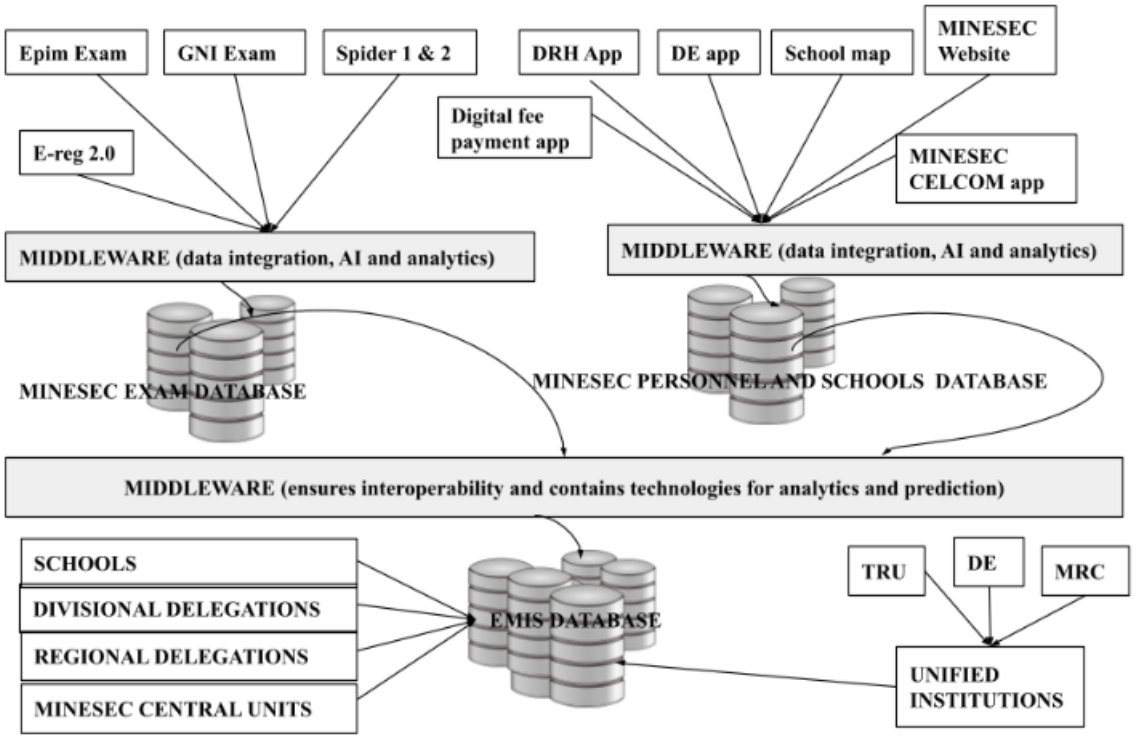
Analysis of all these digitalisation endeavours showed clearly that there is poor integration of the different efforts. Mostly efforts related to software implementation. We can see this from the fact that there each examination board has its own software. Such implementation show signs of immaturity in digital transformation and will lead to data silos and problems of compatibility. Research conducted by Kane et al. (2015, 2017) reports that mature organisations focus more on a system-wide approach and integration during digital transformation, while less mature digital organisations are focused on solving discrete business problems with individual digital technologies. Faeste et al. (2019) support Kane (2015, 2017) by adding that successful organisations focus on system-wide transformation programmes rather than a series of ad hoc improvements. An outcome of digital transformation is to ensure data that often comes from a multitude of disconnected sources is connected, contextualised, and personalised to the user's requirements.

We still see this poor integration at the level of the Distance Education programme, MRC programme and the TRU which have intersecting responsibilities. These programmes and the TRU could integrate their efforts and resources to reach a common goal. This poor integration can still be seen at the level of the local efforts implemented by the regional delegates. Each regional delegate had his own plan of action towards the digitalisation of secondary education.

All these siloed efforts can be integrated into one combined effort to focus the digitalisation of secondary education. We propose a coordinated data integration and governance model for integrating the different programmes, technologies, and institutions participating in the digitalisation of secondary education. This model will focus on creating a unified framework that allows for efficient data sharing, policy alignment, and technology interoperability across the central and deconcentrated services of MINESEC. Figure 11 depicts this data integration and governance model.

Figure 11

Integration of siloed efforts to sub-sector wide EMIS



Source: author

This model shows that existing data can be federated in two clusters: a cluster for exam data and another cluster for existing personnel and other MINESEC applications. These clusters will be able to exchange data between through the central EMIS database. We have two different clusters for performance and security reasons. Access and workload on the examination database can be periodical while there is steady access for the other activities. The two clusters thus have different workloads and separating them can help improve performance. Also, examination data may be sensitive and subject to stricter regulatory requirements. Isolating this data can enhance security measures and simplify compliance with data protection regulations.

Moreover, the model shows that each cluster has specialised artificial intelligence and analytics technologies to measure and predict different key performance indicators.

This federated data model can be implemented through an EMIS (central data hub) that aggregates data from all silos. This hub can support various data formats and sources, allowing for seamless data ingestion from different technologies. Data virtualisation technology will provide a unified view of data across silos without requiring the data to be physically moved. This will allow the different concentrated and deconcentrated services of MINESEC to access and query data from multiple sources as if it were a single repository. APIs and microservices will be used to facilitate data exchange between different systems and services.

For data that will be generated after the integration of current siloed technologies, a cross-functional committee that includes representatives from the central and deconcentrated services will work to decide data governance policies, standards, and procedures. These policies and standards will include data privacy, access control, data retention, and compliance with legal regulations. The outcome of the working session of these cross-functional committee will be common data formats, protocols, taxonomies, access, and security compliances that all technologies and units from central and deconcentrated services must adhere to. This will reduce the complexity of integrating data from different sources and eliminate data silos.

This model also proposes that the EMIS will be the system that all schools, divisional delegations, regional delegations and other central services of MINESEC will use. These services will directly input the data they generate in the EMIS system and if there is need for a particular technology, it will be integrated in the EMIS. The different units and programmes running the digitalisation of secondary education will be unified into one institution and this institution will communicate directly with the EMIS.

Implementing such a model will demand training programs to educate staff on the new data governance framework, interoperability standards, and data integration tools and a change management strategy to ensure a smooth transition to the new model. This model aims to break down data silos, ensure consistent policies across institutions, and provide a scalable architecture that allows for the integration of various technologies and data sources. By implementing this model, your MINESEC can achieve better data coordination, improved decision-making, and enhanced collaboration across central and deconcentrated services.

Pain points of digitalising Secondary Education and of key digitalisation efforts performed by MINESEC

In this section, we present the results obtained based on data collected from observation, interviews with experts and key stakeholders, official documents and reports, literature on difficulties faced in the digitalisation of education in general, and difficulties faced in each of the critical case studies chosen for this study. Nevertheless, we give a brief description of each case study and provide some salient information on their achievements.

Our analysis revealed a lot of pain points linked to the digitalisation of education. These pain points are classified into five main categories: digital infrastructure, people, public governance, digital equity and inclusion, and data culture. Digital infrastructure-related issues refer to elements linked to the availability of computers for students and teachers, the availability of power, and connectivity. People-related issues refer to the absence of skills in the general use of ICT and in the teaching and learning process. It also points out issues related to a culture of learning where personnel want to be paid for attending seminars that aim to equip them and poor management of resources by heads of schools. Public governance involves the systematic and well-planned management of the affairs of the state to achieve the purposes established by the government. Governance-related issues refer to the insufficient or absence of mechanisms to coordinate, control, operate, sustain, monitor, or hold accountable people involved in the process of digitalising education. Digital equity and inclusion-related issues refer to actions taken to consider the poor and needy, those in rural areas or areas of conflict, and those with disabilities in the process of digitalising Secondary Education. Data culture refers to an organisational environment where data is not only valued but is also readily accessible and used consistently to drive decision-making processes. It's a culture where data literacy is widespread and data-driven insights are the norm rather than the exception (DataCamp, 2023). The main issues related to data culture are data silos and measuring the efforts of digitalisation endeavours. Table 13 expresses the different categories and their respective pain points.

Table 13

Pain points of digitalising Secondary Education classified into five categories

Category	Pain point
Digital Infrastructure	Very high computer-to-student ratio. Absence of electric power in schools in rural areas. Most students and teachers do not own a computer. Poor internet connectivity in most parts of the country.
People	Teachers do not have skills in the use of ICT. Teachers do not have skills for integrating technology into the teaching and learning process. Teachers resist training and want to be paid for it. Poor management of funds related to computing projects by school heads.
Public Governance	Absence of long-term and system-wide strategies. Difficulties in coordinating the different actors involved.
Digital Equity and Inclusion	Risk of increasing the digital divide. Uneven access to high-quality digital learning opportunities. The current implementation does not sufficiently take care of the disabled and vulnerable groups.
Data culture	Difficulties in tracking the progress of digitalisation efforts. Siloed technologies and data silos.

We now consider each case study and provide the main challenges faced based on the data collected.

Case of the Multimedia Resource Centres programme

The MRCs programme was launched in 2001. The current missions of the MRCs are to:

- train and promote access to knowledge for a greater number of people through ICTs;
- facilitate the sharing of knowledge in all domains;
- provide students with access to a global culture.

Between 2001 and 2008, one hundred and fifty-six (156) monitors of MRCs were trained. Other trainings for administrative staff, support staff, and teachers were performed between 2002 and 2008. In 2001, two MRCs were created in Yaounde. Three (3) other multimedia resource centres were created in 2002. By 2007, the country had seventeen (17) MRCs. By 2011, the country had fifty-nine (59) MRCs spread in the different regions of the country. The country currently has ninety-two (92) MRCs, which are distributed per region as shown in Table 14.

Table 14

Number of MRCs and percentage of schools with MRCs in the 10 regions of Cameroon

Region	Number of MRCs	Percentage of schools with MRCs
Adamawa	8	6.72%
Centre	13	2.64%
East	7	4.35%
Far North	7	2.02%
Littoral	13	6.50%
North	7	1.73%
North-west	7	5.56%
West	9	2.46%
South	13	6.77%
South-west	8	3.14%

Source: adapted from IP-INFO (2021b) and MINESEC (2021)

The percentage coverage of MRCs in the whole country can be estimated at 3.45%. The following are the major pain points identified in the management of MRCs:

- insufficient training of the personnel in MRCs;
- principals are not cooperating with the actors to ensure proper functioning of the MRCs;
- little or no maintenance of the equipment in the MRCs;
- personnel sent to MRCs have ignored the post since they think there is no professional growth or motivation for the work done;
- little or no investment by principals in the MRCs (the computers are outdated);
- unqualified personnel appointed to work in the centre;
- private schools are not included in the project;
- issues related to administrative bottlenecks; for instance, a hall cannot be used if it is not officially received by a high-level administrator of MINESEC.

All these pain points can be matched to the generic pain points linked to the digitalisation of secondary education provided in Table 13. For instance, issues related to administrative bottle necks can be matched to governance, more precisely to the absence of coordination.

Case of the Human Resource Web application

The web application to manage activities in the human resources department was developed in 2018 and has been improved over time. This application has a variety of functionalities, which could be considered separate applications on their own. There are five main features offered by the minesecdrh.cm web application: posting of teachers (PALENCA), personnel information

management, school needs management, evaluation of personnel, and managing training and internships.

One of the key functionalities is PALENCA. PALENCA is a module of the minesecdrh.cm web application that manages the posting of pre-service teachers at the different HTTCs in Cameroon. It gives pre-service teachers pending graduation the possibility to create a preference list of the regions they wish to be posted in and automatically distributes the graduates in the 10 regions of Cameroon based on their performance and available duty posts. The module also makes available the Certificates of Collective Assumption of Duty (CCAD) and the Posting Decisions to each graduate as soon as they are signed. The data collected also shows that the HR department also wants to use this data generated by PALENCA to enrich the personnel database of the HR department.

Another module of the minesecdrh.cm web application permits personnel of MINESEC to request transfers and appointments and conduct an online census by providing updated information on themselves. These services permit users to perform certain duties without necessarily travelling to another place. There is also a module that permits school heads to provide vital information on their school, such as the need for teachers and materials, and even report social cases in their institutions. This module is accessed only by school heads. There is another module that permits teachers and other staff to auto-evaluate themselves or request an external evaluation from an inspector or any competent authority. There is finally a module for managing training and internships. This module gives teachers the possibility of applying for in-service training and tracks personnel on internships. This makes the work of the human resources department easy since they do not have to input data themselves, and it also eases the validation of internship requests. The data collected revealed that the work the HR department could do for a week is now done in a day due to these modules. The applications are well protected so that only personnel concerned with a given functionality are able to use that functionality.

The minesecdrh.cm web application also provides current information for personnel, gives users the opportunity to stay updated with things happening in MINESEC through the android application of CELCOM, helps them to connect directly with MINESEC on social media or email, and gives users the possibility to report teachers that have abandoned their posts.

The following pain points were identified in the minesecdrh.cm web application:

- some services found on the application are not yet operational;
- it does not yet offer services that permit transfer and appointment decisions to automatically update the database;
- it does not provide learning opportunities or digital resources that teachers can use to improve their skills.

Case of the Distance Education programme

The distance education programme was launched in 2020 as a response to the COVID-19 pandemic because education cannot wait. It started with 3 recording studios and an electronic platform for accessing the lessons and providing information for live lessons. Currently, the distance education programme is made up of the following components:

- an electronic platform that provides information on current events and gives access to recorded lessons organised per subsystem, type of education, and per cycle or class. This platform can be accessed via the link: https://minesec-distancelearning.cm/;
- five recording studios where lessons are recorded, edited then uploaded on the platform. The recording studios make use of laptops, video cameras, and interactive whiteboards;
- an e-counselling helpline that provides guidance and counselling services through calls using the toll-free number 1530 which can accommodate 10 callers at a time. This service was launched during the opening of the school year 2022-2023;
- a YouTube channel where recorded lessons and other events of MINESEC can be accessed and viewed. The content in this channel is not organised as on the platform.

The Distance Education Programme, even though it was a response to a situation, has improved in its activities over time. Table 15 and Figure 12, Table 16 and Figure 13, Table 17 and Figure 14, and Table 18 and Figure 15 show the cumulated changes in the number of recorded lessons, live lessons, views, and subscribers from 2020 to 2023, respectively.

Table 15

Cumulated changes in the number of recorded lessons from 2020 to 2023

Year	Cumulated number of recorded lessons
2020	354
2021	2130
2022	7324
2023	8600

Source: Distance Education Centre

Figure 12

Cumulated changes in the number of recorded lessons from 2020 to 2023

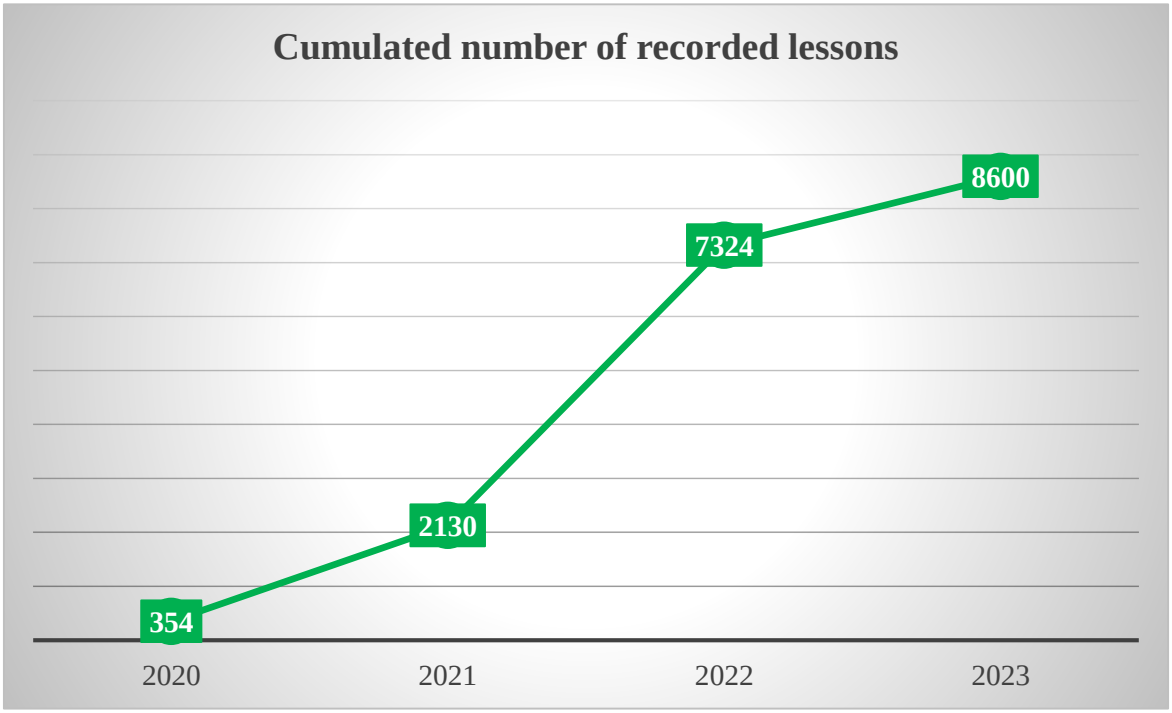


Figure 12 shows a greater increase in number of lessons between 2021-2022 than any other year. 2022-2023 has recorded the least increase in number of recorded lessons. The number of recorded lessons has been increasing since the launching of the Distance education programme in 2020. They currently have 8600 lessons which represents an estimate of 11.5% of the total number resources needed by all the inspectorates of MINESEC.

Table 16

Cumulated changes in the number of live lessons from 2020 to 2023

Year	Cumulated number of live lessons
2020	37
2021	874
2022	1718
2023	2192

Source: Distance Education Centre

Figure 13

Cumulated changes in the number of live lessons from 2020 to 2023

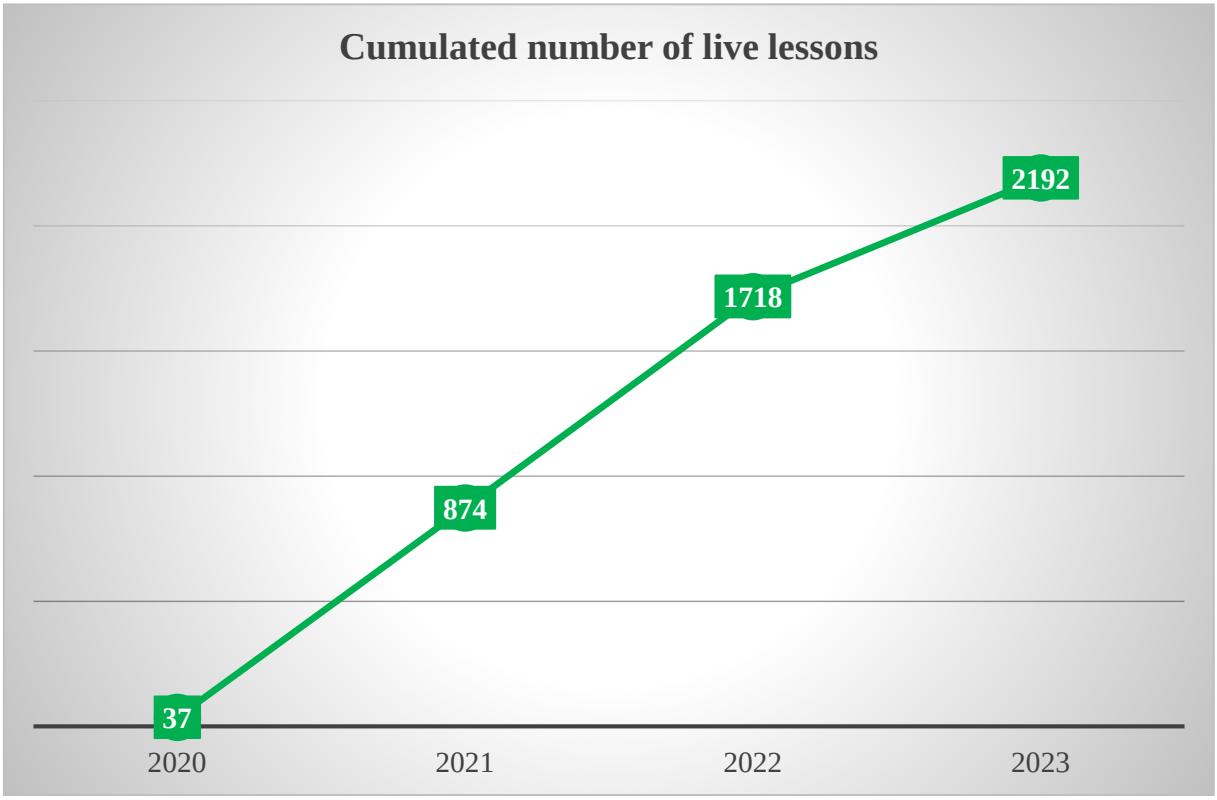


Figure 13 shows a greater increase in the number of live lessons between 2021 and 2022 than any other year. 2022-2023 has recorded the least increase in the number of live lessons. Participation in these live lessons has also been increasing, showing that more and more students and teachers know about the distance education programme and are interested in it.

Table 17

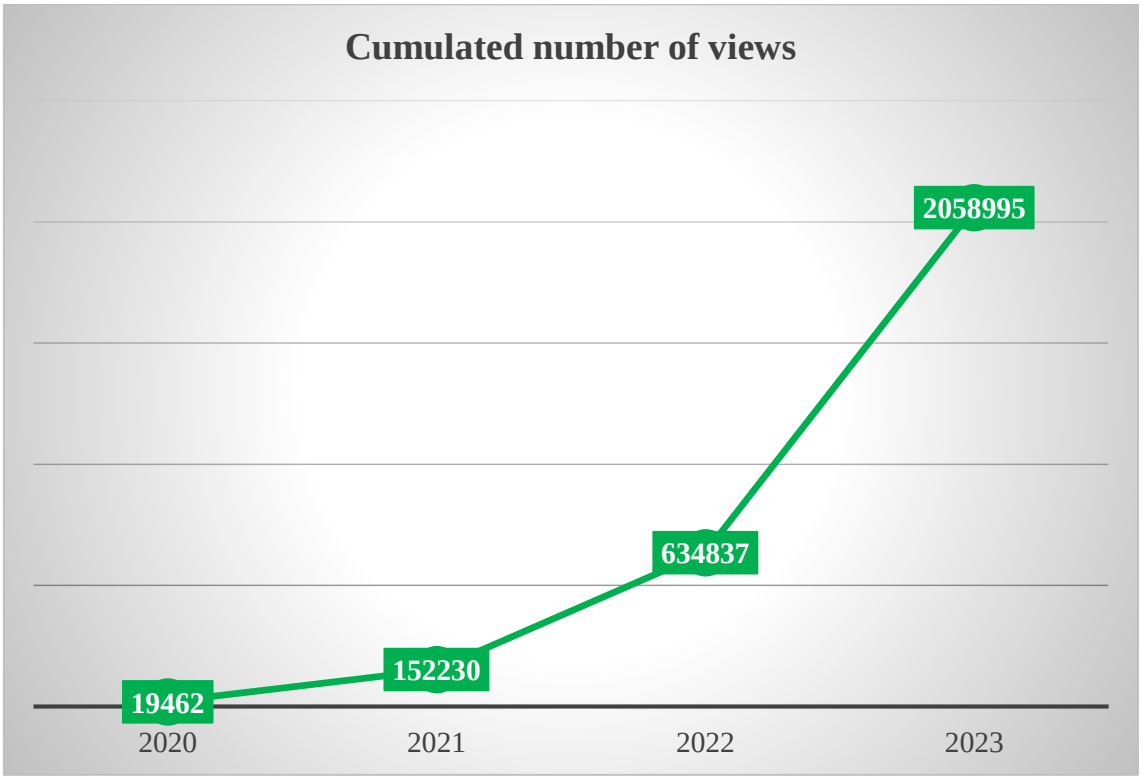
Cumulated changes in the number of views from 2020 to 2023

Year	Cumulated number of views
2020	19462
2021	152230
2022	634837
2023	2058995

Source: Distance Education Centre

Figure 14

Cumulated changes in the number of views from 2020 to 2023



The cumulated number of views have been increasing year after year. Each year the increase is more than the previous year. Showing that more people know about the programme and are getting involved.

Table 18

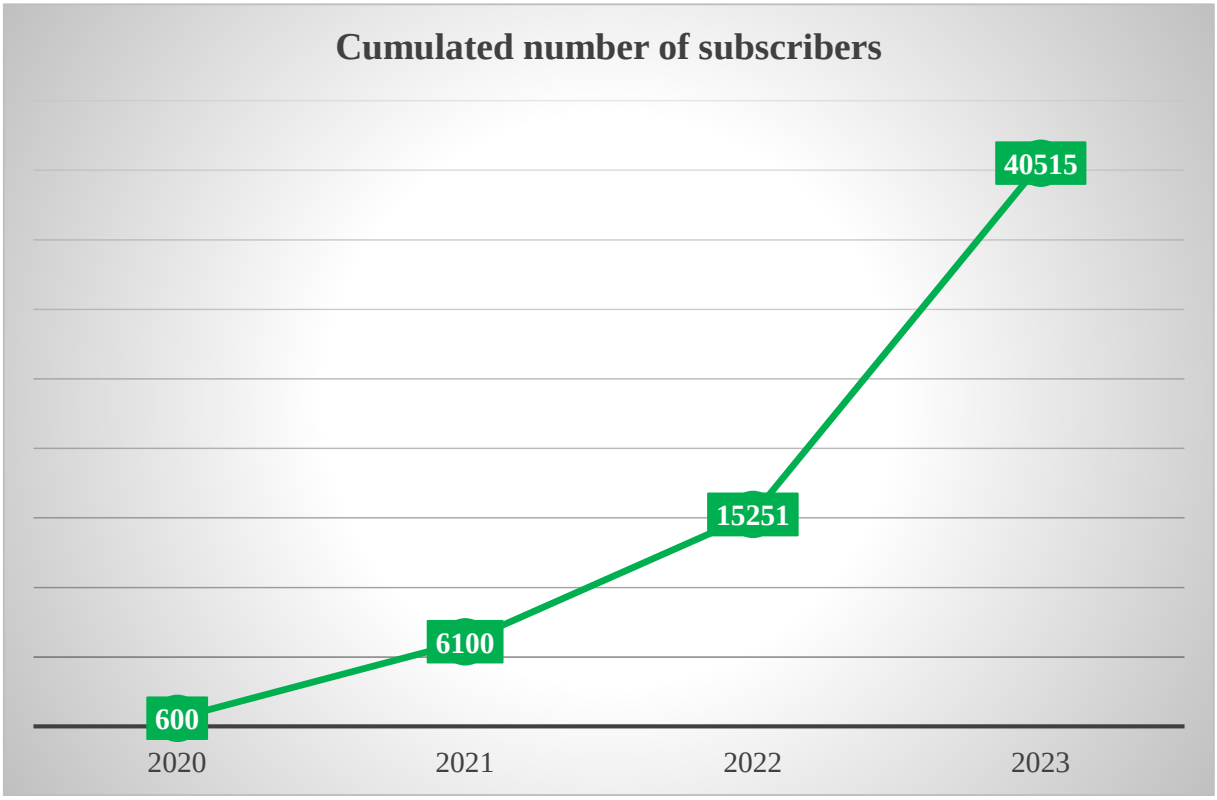
Cumulated changes in the number of subscribers from 2020 to 2023

Year	Cumulated number of subscribers
2020	600
2021	6100
2022	15251
2023	40515

Source: Distance Education Centre

Figure 15

Cumulated changes in the number of subscribers from 2020 to 2023



The number of subscribers has been increasing year after year with each year having more subscribers than the previous one. This shows that more people enjoy the content produced by the distance education programme and want to have more and be notified when new content is published. From this, one can argue that the distance education programme has a positive impact on students and teachers.

Based on the data collected, the distance education programme has also helped some principals to solve problems of no teachers in a given subject or absence of teachers due to maternity leaves or sickness. The distance education programme also supplied more than 20000 tablets with resources stored in it to some schools. These resources helped students with difficulties to access the internet to view the resources from the tablets without internet connection. These lessons were also loaded in external hard drives and distributed to schools. Each school whether private or public just needs to come with an external hard drive and the available resources will be loaded for them to use. This helps to reduce the dependency to connectivity. MINESEC is trying to establish necessary partnerships to curb the inequalities linked to the distance education programme.

The guidance and counselling helpline lunched in 2022 can boast of up to 24 calls each guidance counsellor receives per day. Sometimes these counsellors received calls even out of working hours showing the importance of this service. From the data collected, callers generally have worries of privacy of the data collected during the conversations.

The distance education programme ensured education cannot wait and has brought in a lot to the Ministry of Secondary Education, but it still has some issues that needs to be addressed. The data collected reveals the following pain points:

- insufficient skill of teachers to use computing technologies;
- no way to know who is using the distance learning platform;
- insufficient number of personnels to run its activities;
- counselling helpline limited to a maximum of 10 calls at a time;
- does not favour inclusion or equity;
- insufficient number of recording studios;
- little or no motivation system for teachers;
- poor skills of teachers in techno-pedagogy and multimedia learning;
- no way to measure effective use of the platform (number of views and subscribers is not sufficient).

Each of these pain points can be matched to a category or factor that influences effective digitalisation, as mentioned in Table 13. For instance, no way to measure effective use shows the absence of a data culture, while an insufficient number of recording studios can be matched to infrastructure.

Proposed solutions to mitigate the pain points and promote a successful and sustainable digitalisation

Interviews with experts and key stakeholders and proposals from literature on how to curb issues related to digitalisation are presented in Table 19. These proposed solutions are classified in the same categories as the pain points.

Table 19

Proposed ways of curbing issues related to digitalisation of Secondary Education

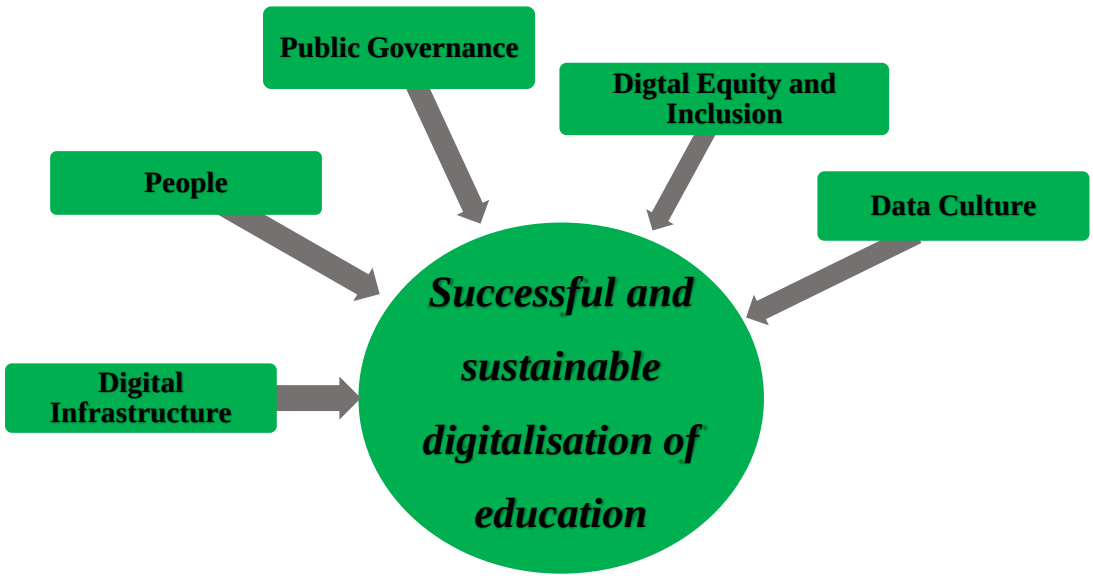
Category	Proposed solution
Digital Infrastructure	Implement the One Laptop Per Child programme and One Laptop per Teacher programme. Create partnerships with NGOs and other organisations to acquire computers at little or no cost. Create policy that encourages all schools to have at least 2 sources of energy. Projects related to connectivity such as national backbone, telecentre, and PATNuC should be accelerated on as mentioned in the PATNuC project document (Republic of Cameroon, 2021).
People	Adjust pre-service teacher education curriculum and define ICT in education competency framework for teachers, students and citizens, then create e-courses for teachers, students and Cameroonian citizens. Create an incentive system to reward quality digital teaching and active participation to programmes and policies linked to the digitalisation of education. Train school administrators on ICT leadership and create indicators to measure how they champion ICT in education projects.
Public Governance	Establish policies that promote hard work, meritocracy and curbs mismanagement and embezzlement. Establish ICT in education policies and masterplans. Establish a steering committee to manage ICT in education projects and place it under the direct authority of the Presidency or Prime Minister. Prepare a long-term financing plan and strategy for sustainable ICT in education and identify funding sources and means of engaging the private sector and international organisations to support ICT in education programmes.

	Enact decrees that promote digital inclusion and equity for ICT in education projects or programmes.
Digital Equity and Inclusion	Create a committee that focuses on the needs of the vulnerable groups and students with disabilities.
	Design a plan for collecting and analysing data on digitalisation programmes and digitalisation in teaching and learning
Data culture	Create data policies and standards
	Develop an automated EMIS to ensure all information systems are linked.

Our analysis thus shows that there are five factors to consider for an effective and sustainable digitalisation of secondary education. These factors are infrastructure, people, governance, equity and inclusion, and data culture. Figure 15 depicts these factors.

Figure 16

Factors influencing a successful and sustainable digitalisation of education



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CHAPTER 5: DISCUSSIONS, CONCLUSION AND PERSPECTIVES

Discussions

We will discuss the five categories of factors classified in this study that influence the successful digitalisation of education.

Digital Infrastructure

Miao et al. (2022), Akumbu et al. (2021), Manyengo (2021), Yigezu (2021), OECD (2021), UNESCO (2013), Ansoy (2022), McCarthy et al. (2023), NAICT (2007), Haji et al. (2017), Nsolly & Charlotte (2016), Le Pham (2021), Patterson (2020), MoE Korea (2017), UNESCO (2021a), Brunetti et al. (2019), MoE Montenegro (2022), Twagilimana and Barbutiu (2017), Republic of Cameroon (2010, 2015, 2020) all agree that reliable digital infrastructure is a basic step in any digitalisation process. The experts interviewed all affirmed the importance of computers, connectivity, and electric power as components of digitalisation. The importance of infrastructure can still be seen at the level of local policies instituted by the Regional Delegates of Secondary Education. In their plan to promote digitalisation, encouraging principals to buy digital equipment was instituted by all of them. The importance of infrastructure can still be seen in the Multimedia Resource Centre programme and the Distance Education programme. One of the key actions in these programmes was the acquisition of the necessary digital infrastructure. The Distance Education Centre has computers, video cameras, interactive whiteboards, a reliable connection to the internet, an electric generator, etc. that ensure the centre can run all its activities without interruptions.

This study revealed issues related to infrastructure such as a low student-computer ratio, unreliable electric power and internet connectivity in some areas, and the non-possession of computers by students and teachers. The high student-computer ratio is because, out of the more than 2200 public secondary schools in Cameroon, with more than 1.300.000 thousand students, there are only 1000 computer rooms with 21230 functional computers (IP-INFO, 2021b). This leads to a student-computer ratio of 62:1, which means that at any given time, one computer is used by 62 students (IP-INFO, 2021b). This statistic involves only public secondary schools. This ratio will get wider if private schools are included in the data to compute the student computer-ratio.

Issues related to electric power and poor internet connectivity are high in most African countries (Manyengo, 2021; Makossa, 2013; Josue, 2007; Nsolly & Charlotte, 2016; Twagilimana & Barbutiu, 2017; Yigezu, 2021; Barassa, 2021, 2023; Saka, 2021; Mugiraneza, 2021; Konayuma et al., 2023; Barussaud et al., 2023; Ndayambaje, 2023; African Union, 2015; Republic of Cameroon, 2020; Tchamabe, 2010, 2011; Quaicoe et al., 2023; Nkwenti, 2015, 2016, 2021b; Béché, 2020). In Cameroon, most rural areas have an electricity access rate of about 20 percent (Republic of Cameroon, 2020). Most rural areas have an unstable supply of electricity, while others do not have access to electricity, some due to the crisis in the North-west and South-west regions. Electric power being the base of all digital activities, its absence or instability is a major drawback to digital transformation. The broadband internet access rate in 2015 was just 4%. The telecommunications development strategy in Cameroon is based on connecting households and companies to the optical fibre already installed, improving the quality of the internet, and improving broadband internet accessibility for all at a lower cost (Republic of Cameroon, 2020). Key digitalisation endeavours launched by MINESEC depend on internet connectivity. For instance, most of the activities in the Distance Education Programme—live lessons, the electronic platform, and the YouTube channel—depend on access to internet connectivity. Béché (2020) affirms that the generalisation of access to essential services such as electricity, television, and the internet are indispensable for the development of distance learning.

Studies conducted by Akumbu et al. (2021), Nkwenti (2021b), Nsolly and Charlotte (2016), Josue (2007), and Feugueng et al. (2015) highlight the fact that teachers do not have computers. Most research has highlighted the lack of skills in the use of ICT as a major drawback to the effective digital transformation of education. This issue of teachers not having computers is also found in most African countries; that is why countries like Rwanda and Ghana are instituting the One Teacher One Laptop programme. The One Laptop Per Child programme implemented in most countries like South Africa, Kenya, Rwanda, and Ghana, and the fact that the African Union signed a partnership with the One Laptop Per Child NGO, shows how most students in Africa do not have their own computer. In Secondary Education in Cameroon, most of the students owning their own computers are those of specialised series such as the TI series. According to the Republic of Cameroon (2020), the percentage of students in the science and technology series in secondary education is represented by just twenty percent. All of these students do not own a computer. Data collected highlighted the fact that most students use their parents' digital devices to attend live lessons of the Distance Education Programme or interact

in social media groups created for educational purposes. This again affirms the fact that most students do not own their own computers.

To deal with infrastructure-related issues data collected revealed that schools can reduce the student-computer ratio by engaging in partnerships to acquire computers at a very low cost. As was the case with the Regional Delegation of the South-west which permitted schools to get complete, high-quality computers at a very low cost by partnering with an NGO. The Computing Project designed by MINESEC aims at regulating the purchase and maintenance of computers by school heads. The vision was to reduce the student-computer ratio from 62:1 to 28:1 by the end of the 2022 academic year (IP-INFO, 2021b). Also, schools should be provided with a specific budget to entertain alternative sources of energy, such as solar or electric generators. This goes in line with the vision of the Minister of Secondary Education, who instructed schools to always make sure they have at least two sources of energy to reduce issues related to electric power. The President of the Republic, his Excellency Paul Biya, in his 2015 end-of-year speech, insisted on the fact that one of the ways we accelerate the industrialisation of Cameroon is to ensure the availability of an adequate and permanent energy supply (Republic of Cameroon, 2015). Republic of Cameroon (2020) also shows that the Government intends to alleviate the energy crisis by developing the huge national hydroelectric potential of the country, developing alternative energies to better meet specific needs, and strengthening and optimising the use of biomass. For connectivity, the Government can accelerate the current projects to spread connectivity in all areas of Cameroon and arrange for a different cost of connectivity for education purposes. Projects of MINPOSTEL, such as Telecentre and the national backbone project (MINPOSTEL, 2017), can help increase the connectivity of schools in Cameroon and of communities in rural areas. These proposals are in line with UNESCO (2021a) and the Republic of Cameroon (2010, 2015, 2020).

Moreover, the State can implement a programme like the One Laptop Per Child programme where students with low-income parents, those with financial difficulties, and those with disabilities are provided with an appropriate computer. Such an action will not only help mitigate issues related to access to computers but will also solve issues related to inequalities and equity. Such a programme can be implemented in different ways. One of them is a completely free scheme where parents are not contributing. Another one can be a scheme where parents provide a percentage of the cost, and the Government covers the rest. The Government can also organise partnerships with organisations like the One Laptop per Child organisation or other organisations to supply computers for free to students, or they can build a factory for

assembling computers and distribute these computers in phases to students. The idea to build a factory for assembling computers is mentioned in MoE Rwanda (2015), GNAT (2021), and Republic of Cameroon (2020). The idea of partnerships for effective digital transformation is emphasised in Nsolly and Charlotte (2016), Michaelca (2017), McCarthy et al. (2023), and MoE Rwanda (2022). For teachers, the government could launch a One Laptop Per Teacher programme. Where teachers subscribe to it and pay part of the amount while the State pays the other part. Such an initiative has been done in Ghana, where the State pays 70% and the teachers' pay 30% (GNAT, 2021). The computers distributed to teachers are fabricated in Ghana. MoE Rwanda (2022) also mentions implementations of the One Laptop Per Teacher (OLPT) initiative. Rwanda tried a scheme where teachers were given a 3-year loan but still did not get a lot of subscribers. They are now intending to fully fund the current initiative of One Laptop Per Teacher with funds from the national budget and help from ICT in education development partners. The Ministry of Education of Guyana, a country in South America, also implemented the one laptop per teacher programme (MoE Guyana, 2021). In the Adamawa region, a principal from a lay private school implemented a loan scheme where teachers were expected to choose a laptop that cost between 100000 FCFA and 120000 FCFA, and he would deduct 10000 FCFA per month from their salaries to pay for the computers. This will ensure his teachers are equipped with computers and ease their resistance to integrating technology into their classroom practices. This goes in line with Lewin's change model, which focuses on removing or reducing restraining forces that inhibit change rather than increasing the forces pushing for change (Schein, 1995; Hayes, 2014).

People

The importance of people, most importantly employees or leaders, at all levels of an organisation undergoing digital transformation is emphasised in Kane (2015, 2017, 2019a, 2019b), Manyengo (2021), McCarthy et al. (2023), Cohen et al. (2019), Cortezallo et al. (2019), Patterson (2020), Brunetti et al. (2019), MoE Montenegro (2022), Miao et al. (2022), Yigezu (2021), Barassa (2021, 2023), Saka (2021), Mugiraneza (2021), Konayuma et al. (2023), Barussaud et al. (2023), Twagilimana and Barbutiu (2017), Ndayambaje (2023), Nkwenti (2015, 2016, 2019, 2021a, 2021b), Tchamabe (2010, 2011, 2013, 2015). One of the experts interviewed proposed that digitalisation should be planned at the level of the nation, region, division, school, classroom and even the home, and the leaders at each level are key to the success of digitalisation at that level. Another expert said digitalisation in schools will not succeed without the principals championing the project. Infrastructure is important, but without

the people to exploit the infrastructure and ensure the respect of norms, the process of digitalisation can be likened to a computer without a user to operate, configure, and exploit it.

The main people-related issues with the digitalisation of education in MINESEC were the poor skills of teachers in the use of ICT in general and to integrate ICT in the teaching and learning process. We also highlighted the reticence of teachers to training and poor management of computing funds by school heads. The poor skills of teachers in ICT or techno-pedagogy in Cameroon are highlighted in Josue (2007), Nsolly and Charlotte (2016), Nkwenti (2015, 2016, 2019, 2021a, 2021b), Tchamabe (2010, 2011), Akumbu et al. (2021), Béché (2020), Feugueng et al. (2015), Haji (2015), Haji et al. (2017). Issues related to the poor skills of teachers are highlighted in the case studies. The Regional Delegation for the Centre region, in their report on the state of digitalisation in the Centre region, reported the insufficient skills of teachers in ICT as the main obstacle to the digitalisation of education. This aligns with the feedback from interviews with experts and other actors. One of the reasons for this insufficiency in digital skills and techno-pedagogic skills is due to the insufficiency in the pre-service training of teachers (Feugueng et al., 2015; Tchamabe, 2015; Haji, 2015). An expert also affirmed that even the in-service training conducted is generally not effective because it is generally a one-time training with little or no follow-up mechanisms.

Decree No. 200/697/PM of September 13th, 2000, defines schemes for the continuous training of civil servants. This shows how the Government of Cameroon recognises the importance of continuous training. Continuous training is one of the key components used by MINESEC to ensure teachers are constantly gaining new skills, but teachers are generally reticent to these trainings. This can be observed by the number of teachers attending pedagogic days, training seminars, and their attitudes during the training. One of the experts expressed this fact by saying that teachers want to be paid when they attend training seminars. Another expert explains that generally humans want to stick to the status quo, so bringing in new ways of doing things will generally start with resistance. The researchers experience during the different trainings organised in the framework of the Distance Education Programme confirms the view of the experts.

One expert said ICT integration will only work in schools if school heads embrace it wholeheartedly and are not trying to swindle funds allocated for the development of computing in schools. This claim can be supported by Circular No. 12/17/C/MINESEC/CAB of August 9th, 2017, the elaboration of the Computing Project Guide in 2021, and Note 58/22/AR/MINESEC/SG/IP-INFO of January 7th, 2022. Also, one of the actions of some

Regional Delegates to ensure effective digitalisation of teaching during the 2022–2023 academic year was to devise strategies to encourage school heads to provide the appropriate infrastructure. The Delegates of Adamawa and the South-west region started their digitalisation campaign with the training of principals and encouraged them to buy ICT tools. The Delegate of the Centre region created a local policy document that was a moral contract between principals and the delegate to purchase a minimum number of tools needed for digitalisation. The Regional Delegate also instructed the Divisional Delegates to thoroughly follow up and ensure that principals purchase these tools. The Computing Project Guide (IP-INFO, 2021a) can be seen as a mechanism to ensure heads of schools use funds dedicated to computing projects correctly.

As recommendations, the insufficient digital and techno-pedagogic skills of teachers could be curbed through training. One way of making sure teachers seamlessly accept the process of digitalisation is through professional development, including individualised coaching and personal reflection (Drennan & Moll, 2018 as cited in McCarthy 2020; Kraft & Blazer, 2017; Yendol-Hoppey & Dana, 2010; Haji, 2015, 2017). There is ample literature that confirms well-designed and inspiring professional development has a positive influence on teacher practice, leading to improved student learning (Gutierez & Kim, 2017, as cited in McCarthy 2020; Kools & Stoll, 2016; Nkwenti, 2015, 2016, 2019, 2021a, 2021b). However, teachers also require that their contextual needs be met, including the infrastructure to support the use of technology for teaching (Chou & Block 2019, as cited in McCarthy 2020; Moreira et al., 2019, Feugueng et al., 2015). Meeting these infrastructural needs of teachers will put them in a position where they are more disposed to accept the change.

The Distance Education Programme started with the training of teachers and has had a lot of training to ensure administrators in the central and deconcentrated services of MINESEC and teachers have the necessary skills to support the digitalisation of Secondary Education. Trainings sponsored by UNESCO on the digitalisation of education were done in Mbankomo, Ebolowa, and Douala. Other trainings on preparing digital resources were done in Buea and Yaounde. Teachers were trained on how to prepare a digitalised lesson during the pedagogic day for the academic year 2022-2023. But one-time training is generally not enough. The Regional Delegation for the Centre region proposes a continuous training programme during holidays. An expert proposed the necessity of developing online courses that teachers can access to upskill in the area of digitalisation of education and integration of technology in their teaching and learning practices. Another expert proposed that the lack of skills of teachers in

the use of ICT can be curbed by strengthening the ICT syllabus for preservice teachers and providing long-term training to in-service teachers. To ensure a sustainable solution and promote lifelong learning, a digital competency framework for teachers, citizens, and students should be defined and self-paced digital resources produced so that teachers, citizens, and students can follow. Certificates should be awarded to teachers, citizens, or students that successfully complete different levels of courses in this competency framework. The idea of a competency framework is used in Europe, and MoES Mongolia (2021) also mentions the importance of such a framework. Vuorikari et al. (2022) mention the following frameworks used in Europe: The Digital Competence Framework for Citizens (DigComp), the Digital Competence Framework for Educators (DigCompEdu), and the digital competence self-reflection tools for teachers (SELFIEforTEACHERS) and for schools (SELFIE).

An expert proposed that indicators should be defined to measure teachers use of technology in education and that an incentive system based on meritocracy should be defined to compensate teachers for their efforts in using technology in education. This incentive system should not necessarily be financial; it can be through promotions, surprise certificates of recognition offered by the Minister, Delegate or any competent authority. Such an incentive system will reduce teachers' reticence to training since there will be some benefits attached to upskilling and being competent. To ensure proper management of funds, the Government should create indicators that help measure how funds related to ICT projects are used. Such a tool already exists in the Computing Project Guide. Efforts to follow up, monitor, and control progress to ensure school heads are effectively realising projects related to computing are key to successful digitalisation in schools. An expert proposed that severe sanctions should be applied to school heads that mismanage or try to swindle funds allotted for computing projects.

Public Governance

Governance encompasses the system by which an organisation is controlled and operates and the mechanisms by which it and its people are held to account (Governance Institute of Australia, 2023). The importance of governance in digital transformation is mentioned in McCarthy et al. (2023), Le Pham (2021), OECD (2021), Mai (2022a), MoE Korea (2017), Miao et al. (2022), Kane (2015), MoE Montenegro (2022), UNESCO (2013), MoE Rwanda (2015), MoES Mongolia (2021), Nsolly and Charlotte (2016), Akumbu et al. (2021), Feugueng et al. (2015), Tchamabe (2010, 2011), Manyengo (2021), Yigezu (2021), Barassa (2021, 2023), Saka (2021); Mugiraneza (2021); Konayuma et al. (2023); Barussaud et al. (2023); Ndayambaje (2023).

The absence of long-term and system-wide strategies and difficulties in coordinating the different actors involved in the process of digitalisation are key issues identified that are related to governance. Studies conducted by Kane (2017) revealed that digitally mature organisations have strategic plans that are longer than those of less digitally mature organisations. MoE Korea (2017) expresses a digitalisation of education strategy that was implemented in 5 phases from 1996 to 2018. Miao et al. (2022) express the importance of policy and masterplans when digitalising education. The importance of a long-term vision is also mentioned in Brunetti et al. (2019) and MoE Montenegro (2022).

In Cameroon, there is a complete absence of a sector-wide strategy for the digitalisation of education (UNESCO, 2015; Tchamabe, 2010, 2011; Nsolly & Charlotte, 2016; Haji et al., 2017). The Distance Education Programme, which is one of the major turning points in the digitalisation of Secondary Education is a response to the COVID-19 pandemic. One of the actors interviewed expressed the importance of now slowing down and building a strategy to ensure the Education Programme becomes a way of learning and not just a response to a crisis situation. An expert expressed the lack of coordination between the Distance Education programme, the MRCs programme, and the TRU. The expert blamed this lack of coordination between digitalisation efforts on the absence of long-term strategies and policies to define how these entities can work together. Another expert insisted on a common definition between all stakeholders of what digitalisation of education really means to MINESEC. They insisted on a shared vision between all stakeholders in central administration and deconcentrated services and expressed the necessity of a policy document to explain it and define what is to be done by each actor.

Atenga (2012) mentions how there is generally a conflict of interest in the missions and prerogatives of bodies managing ICT development in Cameroon. This can be seen in the digitalisation of Secondary Education at the level of the Distance Education Programme, the MRCs programme, and the TRU. All these entities are in charge of producing digital resources and are responsible for the digitalisation of Secondary Education. There is no policy document clearly explaining how these entities can work together or defining how the output of one entity can be the input of another. The absence of coordination is still seen at the level of implementation of digitalisation in education in the different regions of Cameroon. Each region has a strategy of its own, prioritising different elements of the factors that influence successful digitalisation. Even though all the regions focused on acquiring ICT tools, training, and vulgarising the Distance Education Programme, there is still an absence of cohesion between

the regions. These differences in strategy in the regions may still be harnessed positively if a review meeting is held to discuss strategies that are working and document them (a lessons learned database). PMI (2017) expresses the importance of the lessons learned database and explains how it is important during programme definition. The MINESEC central administration and its Regional Delegations can use the lessons learned from each region to define a way forward that is based on practice on the field. An expert mentioned how the lack of coordination between even Ministries in Cameroon will be the reason why digitalisation of Secondary Education will not be effective and sustainable. The expert explained that there are components of digitalisation in education that do not depend on the Ministry of Secondary Education, such as reliable connectivity and energy. The expert claimed that such components that demand coordination between Ministries will be a huge bottleneck to the effective digitalisation of Secondary Education. It is important to mention that MINESEC is already working in collaboration with MINPOSTEL and its bodies, such as NAICT, and other programmes like PATNuC to ensure an effective digitalisation of Secondary Education. CELCOM (2022) mentions how MINESUP and MINESEC are working on how they can mutualise their efforts to ensure an effective digitalisation of Secondary Education. This shows that MINESEC is aware of the importance of collaborating with other ministries to ensure the successful digitalisation of Secondary Education.

To curb issues related to governance, the opinion from experts and literature is that the Cameroonian Government should develop an ICT in education policy document and masterplan for all the educational subsectors that spans over a period of at least 10 years. Also, the committee in charge of the integration of ICT in education should be rekindled, or another committee or programme should be created and placed under an authority (the Presidency or Prime Minister's Office) that can easily coordinate the actions of different ministries (MINESEC, MINEDUB, MINPOSTEL, MINEPAT, MINDDEVEL, MINEE). Such a committee can play a role in the successful and sustainable digitalisation of education. One expert insisted on running projects and programmes based on standards of project and programme management. He insisted that in Cameroon, standards are respected only for some components. He added that if standards were respected for all the elements of a project as prescribed by experts, the rate of success of projects would be very high. The experts also talked about a review of the different policies and how to use them to create coordination. Policy as a means of achieving coordination is supported by UNESCO (2013). The experts mentioned the importance of financing and the motivation of actors involved in the digitalisation process.

Planning the financing of digitalisation of education is supported by Brunetti (2019), OECD (2021), MoES Mongolia (2021), Miao et al. (2022). Even though education took 40% of the 10 most budget-intensive programmes for the 2023 Cameroon budget, with MINESEC having 30% of the budget programmes (Republic of Cameroon, 2023), the experts think that the Government should still try to allocate a special budget for the digitalisation of education and work with partners that can support ICT in education projects in Cameroon. Republic of Cameroon (2020) shows that the Government intends to increase the budget allotted for education from 13.2 in 2019 to 20.8 by 2029. This increase in budget can be used to finance components like the digitalisation of education. The experts also think that the promotion of actors (teachers, principals, Regional Delegates, Directors) should be based more on meritocracy and a track record of positive results than longevity of service or other factors.

Digital Equity and Inclusion

Equity and inclusion have been major objectives in education systems. Barassa (2021, 2023) mentions how the strategic objectives of the National Education Sector Plan for Kenya are to enhance the equity, quality, and relevance of education, and Yigezu (2021) mentions the General Education Quality Improvement Programme for Equity (GEQIP-E) for Ethopia. Republic of Cameroon (2020) affirms that one of the key objectives of the Government is to reduce regional disparities in terms of school infrastructure and teaching staff, and one of their interventions is structured around access and equity. The Government plans to put in place a mechanism to ensure access to education and training for all segments of the population. Other countries like Tanzania (Manyengo, 2021); Malawi (Saka, 2021); Cote d'Ivoire (Barussaud et al., 2023), and others have as one of their missions to promote equity and inclusion in their educational systems. This goal is in line with the declaration they made to address all forms of exclusion and marginalisation, disparities, and inequalities in access, participation, and learning outcomes (UNESCO, 2016a).

Unfortunately, Cameroon and most of these countries do not have a plan to ensure inclusion and equity when it concerns the integration of technology in education. This does not go in line with the prescription provided in Miao et al. (2022), which states that the implementation of ICT in education must start with the adoption of humanistic principles and should pay special attention to the challenges of inclusion, equity, and gender equality. The principles necessitate addressing two imperatives: the use of education to close the equity and gender divides in access to ICT and in digital skills; and ensuring inclusion, equity, and gender equality in all ICT in education programmes.

This study identified three pain points linked to equity and inclusion: the risk of increasing the digital divide, uneven access to high-quality digital learning opportunities, and the fact that the current implementation of digitalisation in Secondary Education does not sufficiently take care of the disabled. Issues related to an increase in the digital divide are in line with Armila et al. (2022), Haji et al. (2017), and Tchamabe (2013). Tchamabe (2013) claimed that the introduction of computer science as a subject will create an inequality between rich and poor students and increase the digital divide. Haji et al. (2017) affirm that teachers in rural areas have less opportunity to use ICT in their teaching compared to their colleagues in urban areas; this is partly due to the lack of electrical connectivity in the countryside. While Armila (2022) posits that digitalisation can sometimes strengthen the prevailing educational gaps between different sociocultural population groups if digitalism is not paying attention to human and societal conditions. Also, insufficient infrastructure was a key issue in digitalisation which is in line with Tchamabe (2010), who claims that insufficient infrastructure can increase the digital divide. This view is supported by the experts interviewed. Tchamabe (2010) also claims that this digital divide has a consequence on the teaching practices and skills of teachers. Feugueng et al. (2015) confirms this, as he affirms that a lot of teachers do not have computers, and those who do are more likely to accept changes related to the integration of ICT in classroom practices. Experts think that it will take time for this digital divide to be closed because of the quantity of infrastructure needed to completely eradicate it and the poor digital culture of Cameroonian citizens. This is coupled with the fact that the government of Cameroon projects to drop the digital divide from 71.81% in 2015 to 50% by 2029 (Republic of Cameroon, 2020). This implies there is still much work to be done to ensure a drop in the digital divide. The experts interviewed think that as long as there are issues related to basic ICT infrastructure, there will be issues of digital divides and thus uneven access to high-quality educational opportunities. For instance, during live sessions of distance education lessons, only schools with a reliable source of energy and connectivity and students with these facilities can comfortably reap the benefits of these lessons.

Analysing the implementations of ICT in education integration projects since 2001 and observing the implementation of key digitalisation of education programmes such as the Distance Education Programme, we noticed that there has been little effort and priority to take care of learners with disabilities and vulnerable groups. Even though one of the interviewed actors explained that Cameroon is a poor country and cannot solve the problems of all stakeholders at the same time, priority is given to the majority. This actor added that for now

they are trying to solve the problem for those without disabilities first and will focus on the other groups in future phases of the project.

Tchamabe (2010) affirms that the construction of MRCs was a way to reduce the digital divide. Thus, supporting the point that one of the ways of reducing the digital divide is by providing adequate ICT in education infrastructure in schools and the community. Implementing programmes such as One Laptop Per Child and One Laptop Per Teacher can reduce the digital divide significantly. An expert proposed that the acceleration of projects such as the telecentre project and the national backbone project and partnerships with organisations that can provide or fund some key initiatives will help reduce the digital divide. This is in line with the Government's plans to neutralise the digital divide by promoting a synergy of actions from strategic partnerships between the State and major national and international private operators, continuing to expand the optical fibre network, building two data centres, and implementing an electronic governance system (Republic of Cameroon, 2020). Also, the digital divide at the level of skills can be solved through training. Tchamabe (2010) highlights how some organisations are training teachers to reduce the digital divide. Based on issues related to the 'eco-digital divide' mentioned in Tchamabe (2013), specific infrastructure to curb the effects of the environment on digital devices should be provided to areas with such problems.

An appropriate and reliable digital infrastructure will help solve the problem of uneven access to high-quality digital resources and services. Interviews with some actors show that MINESEC is aware of these inequalities and is taking action to curb them. For instance, in the Distance Education Programme, recorded lessons have a print version, which would be printed and sent to areas that have issues accessing the platform. Even though the experience will not be the same as in the case of a recorded lesson, it will at least reduce the effect of the inequality. Also, the Distance Education Programme distributed 15000 tablets loaded with Distance Education resources to some schools in the 10 regions of Cameroon and is planning to acquire and distribute another consignment of more than 75000 tablets. This can help bridge the access gap to these resources for schools with internet connectivity issues and unreliable power supplies. Moreover, MINESEC is also working in partnership with Commonwealth to acquire devices called micro-clouds, which can store digital resources that can be accessed via a WiFi network even when there is no internet. Other digital endeavours, such as the digital payment of fees, are implemented in an inclusive way by providing a variety of options through which the fees can be paid and ensuring that those without smartphones and internet connections can still use the service through the USSD code.

To solve issues related to learners with disabilities, MINESEC must intentionally plan on how to manage such groups and secure the necessary financing to acquire tools and train stakeholders. UNESCO (2016b) proposes that educational facilities that are sensitive to disabilities be built in schools. We propose that a steering committee or programme that focuses on the needs of vulnerable groups and students with disabilities be created for the integration of ICT in education. This committee or programme should be directly controlled by the Presidency or Prime Minister and should work hand in hand with the committee in charge of the integration of ICT in education, or it should be a service in the ICT in education committee or programme. Ndayambaje (2023) talks about the Digital Ambassador Programme (DAP), which is a digital inclusion initiative aiming at realising the Digital Talent Policy of Rwanda. Such programmes aiming to tackle issues related to equity and inclusion are the best way the Government can intentionally tackle issues related to equity and inclusion. Tchamabe (2013) supports this statement by affirming that planned change and governance can help reduce issues related to inclusion and equity. We also propose that the Government should create policies that help promote digital inclusion in all projects related to the digitalisation of education. Promoting digital inclusion is the prerequisite and preconditional policy decision for any national ICT in education policy or masterplan (Miao et al., 2022).

These proposals are in line with the plans of the Cameroon Government since they aim at strengthening the social function of the State and promoting the well-being of the population, especially the most vulnerable. The Government intends to consolidate the achievements and extend the scope of social protection to the greatest number, gradually integrating all social categories hitherto on the fringes of the system through the reduction of social inequalities, taking measures to protect against all forms of vulnerability, and social cohesion and inclusion. To achieve these objectives, the authorities aim at strengthening and extending indirect transfer mechanisms for free services and targeted subsidies benefiting the poor and vulnerable; ensuring the effective application of existing texts on social protection, particularly for children; and continuing to implement support and assistance programmes for young people. (Republic of Cameroon, 2020).

Even though we said ICT can increase the digital divide and create issues related to equity and inclusion, it can also help curb issues related to equity and inclusion. World Bank (2003) and African Union (2004) as cited in Haji (2015) believe that ICT in education can increase access to education and broaden the availability of quality education material in emerging global economies. Haji et al. (2017) affirm that ICT in education has a multiplier effect, and one of

the ways it provides this effect is by reaching students with poor or no access. ICT can provide new, more flexible ways to access quality teaching, learning content, and other educational resources. It can expand access and enable teaching and learning that is less dependent on the co-location and synchronicity of teachers and learners. This is particularly important for students in marginalised, deprived, and less advantaged populations. So long as there is a minimum level of data infrastructure and digital devices, it is also possible to use ICT-based approaches to continue schooling and technical training in areas hit by conflicts or natural and global health emergencies that render normal educational operations near impossible. If data infrastructure or digital devices are not available, teaching and learning can be provided through radio, TV, and even by community speakers (Miao et al., 2022). For instance, a school in the Centre region reduced the effects of teacher shortages in her school by projecting distance education resources for those subjects during school periods and inviting teachers from nearby towns once every fortnight to answer the questions of the students. This helped reduce the effect of the unequal distribution of teachers and included these students in the set of students that are having classes on those subjects. This view is supported by Barassa (2023), as he also mentions how some school heads in Kenya have used ICT infrastructure to address teacher shortages. Miao et al. (2022) believe that the integration of ICT in education has the potential to achieve SDG4 goals.

Data Culture

Reliable data is a key ingredient for decision-making in every organisation. Monitoring and control of programmes is a key supporting activity in the delivery of any programme (PMI, 2017; Luena, 2012). Effective monitoring and control depend on reliable data and timely analysis and feedback (UNESCO, 2016a; UNESCO, 2016b; Twagilimana & Barbutiu, 2017; OECD, 2021; Miao et al., 2022; Republic of Cameroon, 2020). Without data, you cannot measure, and if you cannot measure, you cannot improve. PMI (2017) affirms that a programme will likely generate a large amount of documentation, data, and other records throughout its life cycle. How easily this information can be collected, shared, and maintained may have a significant effect on both programme team efficiency and how the programme is perceived by its stakeholders. The information management needs of the programme should be considered as part of programme formulation so that possible financial, organisational, or resource implications can be assessed. Data collection and analysis should be the norm and not an exception to every activity carried out by an organisation (DataCamp, 2023). ICT-enhanced

ways of collecting, sharing, analysing, and reporting data will bring just-in-time provision of information (Miao et al., 2022).

Issues identified related to data culture are difficulties in tracking the progress of digitalisation efforts and siloed approaches to ICT integration in education. Miao et al. (2022) mention the fact that leveraging emerging sources of data to support data collection is a challenge in many developing countries. This is due to a poor data culture and poor integration of technology to collect, analyse, and disseminate educational data. Data collected on the Distance Education Programme shows that it is difficult to effectively measure certain key indicators, such as the number of students accessing the platform, the number of students viewing a video, or subscribing to the YouTube channel. The inability to effectively measure key indicators makes it difficult to measure progress or determine the impact of the Distance Education Programme. One of the experts claimed that he does not even think indicators to measure progress, and the impact of the programme were determined before launching it. This poor integration of technology in administrative activities can be seen at the level of the regional inspectorates for pedagogy, where most inspectorates do not have a computer. Data from the supervision of teachers is written on paper, and there is no tool to analyse the data. Data for teachers on the field is generally collected at the level of the school, of which the central administration of MINESEC is the one in charge of posting, appointing, and transferring teachers. This implies that, if the information system of the central administration is effective, they are supposed to use the data they have to confirm the effective presence of teachers on the field. This process will be more effective than collecting data on teachers from the field. With such an unstructured process to generate and collect data, it is normal that certain activities cannot be monitored effectively.

The research conducted showed that there are a lot of siloed technologies used in MINESEC, such as SIGIPES, the distance education platform, GNI Exams, GCE Registration 2.0, the web application for human resource management, digital payment of fees, and more. All these tools generate data and information. Not to mention the disparate tools used in specific schools and the fact that other services still run their processes manually. We noticed in the research that the choice of technology is decentralised in schools and most services in MINESEC. There is thus no standard on which technology to use, data formats, or collaboration between services. These siloed initiatives implemented by MINESEC, and the absence of standardisation and integration of these different initiatives have led to data silos. Le Pham (2021), McCarthy et al. (2023), Patel (2019), Brunetti et al. (2019), Stedman (2021), CluedIn (2023), Skinner (2022),

Das (2022), Ranchordás and De Gregorio (2019), Bygstad et al. (2015), SourcePro (2022), and Pasham (2022) believe that siloed initiatives are ineffective and have a negative effect on an organisation. This ineffectiveness can be seen in inconsistent data. For instance, a student's name is written correctly in school, in the files of the Regional Delegation, and in the files of MINESEC, but not correctly in the files of GNI exams or GCE Registration 2.0. Ineffectiveness can also be seen in the fact that educational leaders complain of a lack of data or waste time requesting data from the different departments. This also leads to uncertainty about certain metrics needed by leaders. That is why they will also ask the field to provide data on metrics such as the number of civil servants in an institution.

Le Pham (2021), Patel (2019), and CluedIn (2023) believe that the solution to data silos is integration. Stedman (2021), Skinner (2022), Das (2022), Ranchordás and Gregorio (2019), Bygstad et al. (2015), SourcePro (2022), and Pasham (2022) believe that integration, standardisation, and data governance are key strategies in dealing with data silos. Dawson et al. (2018), as cited in McCarthy et al. (2023), propose a systems approach that encompasses appropriate digital initiatives system-wide and their data as sources of guidance system-wide. Research conducted by Kane et al. (2015, 2017) reports that mature organisations focus more on a system-wide approach and integration during digital transformation, while less mature digital organisations are focused on solving discrete business problems with individual digital technologies. Faeste et al. (2019) support Kane (2015, 2017) by adding that successful organisations focus on system-wide transformation programmes rather than a series of ad hoc improvements. An outcome of digital transformation is to ensure data that often comes from a multitude of disconnected sources is connected, contextualised, and personalised to the user's requirements. Through connected and secure ecosystems, organisations have access to data-driven insights to accelerate action with trends, indicators, predictions, and recommendations to improve outcomes, monitor well-being, and increase success (McCarthy et al., 2023).

In the industry, one of the main ways of achieving standardisation and integration system-wide is through the use of Enterprise Resource Planning (ERP) systems (McCarthy et al., 2009, as cited in Bygstad et al., 2015; SourcePro 2022). The industry also believes that data governance is achieved through laws and policies (Stedman, 2021; Skinner, 2022; Das, 2022). Education is less advanced in the process of digital transformation and is advised to learn from the experiences of the industry (Le Pham, 2021; Mai, 2022; McCarthy et al., 2023). Since ERP is a means of dealing with data silos and the equivalent of an ERP in the education domain is an EMIS (Educational Management Information System), we propose that the State of Cameroon

should acquire or develop an automated EMIS so as to have a central system where all educational processes are managed. Many countries like Korea, Montenegro, and Hungary, in their digitalisation processes, consider an EMIS a priority component of the process (MoE Korea, 2017; MoE Montenegro, 2022; OECD, 2021). Miao et al. (2022) also prescribe that an EMIS masterplan should be a key component of all processes to digitally transform the education sector. Also, policies on data formats, which data is accessible by each part of MINESEC, security of data, and a data management strategy should be enacted by the authorities of MINESEC or the State. Republic of Cameroon (2020) to ensure proper follow-up of the national development strategy planned to produce a statistical framework that is based on the following four guiding principles: defining exact outcome indicators at all levels (resources, output, effects, and impacts); producing quality data (relevance, reliability, regularity, and accessibility); effectively using data for decision-making; and establishing partnership in the design and management of the system. The National Statistics Council (NSC) will ensure the operationalisation of these guiding principles through the NSDS. This information system aims to provide a timely and common information platform for the Government, the private sector, development partners, and civil society to monitor progress towards achieving the objectives of this strategy, and to obtain, through transparent information, the support of those concerned by these actions. Such a framework for monitoring and managing the educational sector is an EMIS.

An expert explained that an educational sector-wide EMIS or an integrated set of EMIS for each subsector will be best. He suggested that such an EMIS should give each student a unique identification throughout their school life, from nursery and primary education up to university. He added that such an EMIS will facilitate the identification of key indicators of education, such as the admission rate of boys and girls, the school completion rate, the dropout rate of boys and girls, and more. This idea is supported by Miao et al. (2022), as they explain how integrating AI can help analyse data, produce reports, and even anticipate dropout rates. They also cite the Beijing Consensus related to the necessity and means of using AI technology to enhance an EMIS. Luena (2012) posits that an EMIS provides quality data and information to support the creation of sound policies, making plans, and managing educational resources. A well-functioning EMIS can ensure the achievement of national goals to provide quality education, which is the basis for facilitating economic growth and sustainable development. The government also needs quality data and information to enhance monitoring and evaluation of

the education sector's performance and ensure the right direction for achieving the intended goals and objectives.

Conclusion and perspectives

The purpose of this research was to identify the different efforts implemented by MINESEC to ensure the digitalisation of Secondary Education, identify major challenges, and propose solutions to help curb these challenges. Through interviews, observations, and a deep literature review, we identified digitalisation efforts in MINESEC, such as the Distance Education Programme, Multimedia Resource Centre project, Digital payment of fees, GNI exams, decrees, orders, instructions, and circulars to enforce and regulate practices that support digitalisation. Content analysis on data collected from the different sources enabled us to classify the challenges or pain points into five main categories. These categories are digital infrastructure, people, public governance, digital inclusion and equity, and data culture. Key issues related to the infrastructure identified were electricity and internet connectivity. With people, the main issues were a lack of skills in computing and poor management of computing projects by school heads. Governance-related issues were poor coordination of digitalisation efforts and the absence of a system-wide digitalisation strategy for ICT integration in education. For digital equity and inclusion, we noticed that most of the current digitalisation efforts do not handle learners with disabilities, and there is a risk of increasing the digital divide. The last category of issues was related to a poor data culture and the use of siloed technologies to solve problems.

Recommendations made to curb the pain points were also classified in the same categories as the pain points. Key recommendations to improve infrastructural barriers were to accelerate projects related to connectivity and power and equip students, teachers, administrators, and other services with the digital tools that can help facilitate the digitalisation of education at all levels (national, regional, divisional, school, classroom, and even at home). Apart from intensifying continuous training and adapting pre-service training curriculum, we insisted on the importance of creating a digital competency framework for teachers, students, and citizens that will be coupled with self-paced digital resources at each level of these competency frameworks. Teachers who complete different levels of the competency framework for teachers will be rewarded through recognition, promotion, or any other means of motivation. The proposed actions will help curb issues related to lack of skills, reticence of teachers to training, and ensure quality long-term training, which will have a better impact than one-day trainings that are generally done. Building a long-term strategic plan for the digital transformation of education, creating a committee placed under the authority of the Prime Minister or President,

securing financing, and respecting best practices, norms, and standards when managing projects and programmes are the key actions proposed to improve issues related to governance. Policies to promote digital inclusion and equity and the creation of a committee to take care of the needs of vulnerable groups when integrating ICT in education were the key suggestions made to curb challenges related to inclusion and equity. The creation of policies and standards for data management and the implementation of an automated EMIS were the main considerations to deal with barriers related to data culture.

This categorisation of challenges related to digitalisation of Secondary Education into digital infrastructure, people, public governance, digital equity and inclusion, and data culture was later considered to be the key factors that influence the successful and sustainable digitalisation of secondary education in Cameroon. Among these factors, we think that governance is the most critical. This is because appropriate governance can help tackle issues related to infrastructure, people, digital inclusion and equity, and data culture. UNESCO (2023d) defines governance as the structure and processes, norms, values, and rules of the game through which public affairs are managed in a manner that is transparent, participatory, inclusive, and responsive. The digitalisation of education is a public affair and should be planned and managed appropriately. Digitalisation is a public good, and its importance is recognised by the State since one of their goals, as mentioned in Republic of Cameroon (2020), is to implement an electronic governance system (E-Government).

As perspectives, it will be interesting to study indicators that can be used to evaluate the progress of digitalising secondary education or develop a masterplan for the digital transformation of education, taking into consideration the efforts already made. Moreover, one can also evaluate the effectiveness of digitalisation efforts on student performance or the level of integration of equity and inclusion in ICT in education projects in Cameroon. Also, another study can attempt to measure the effectiveness of the distance education live lessons on student performance.

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Appendixes

Appendix 1: Interview questions

Set 1: Interview Guide for Distance Education Programme

1. What is the Distance Education programme?
2. What are the current projects actively running in the Distance Education programme?
3. How does the Distance Education Centre function?
4. What are the main challenges faced by the Distance Education programme?
5. How do you think these challenges can be solved?
6. What are the plans of the Distance Education Programme for learners in areas where there is no electricity or internet connectivity?
7. What are the plans of the Distance Education programme for learners with disabilities such as blindness?
8. Why is there no possibility to identify learners that visit the electronic platform?
9. What perspectives does the Distance Education programme have?
10. Do you think the Distance Education programme is making positive progress?

Set 2: Interview Guide for Minesecdrh web application.

1. What is PALENCA?
2. What are the features of the Minesecdrh web application?
3. Are there other software developed by the human resource department of MINESEC?
4. Is the Minesecdrh web application integrated to other software or are there other software integrated to the Minesecdrh web application?
5. Do processes such as posting, appointments, transfer affect automatically the Minesecdrh database?
6. Is there a platform with resources to manage teachers' continuous development?
7. How does the Minesecdrh web application assure the correctness of data entered in the system?
8. What plans does the Human resource department have to ameliorate the Minesecdrh web application?
9. What are the major difficulties faced in developing the Minesecdrh web application?
10. How do you think the Minesedrh web application can be improved?

Set 3: Interview Guide for Multimedia Resource Centre Programme

1. What is the goal of the Multimedia Resource Centre programme?
2. What are the difficulties faced by the Multimedia Resource Centre programme?
3. How can these problems be mitigated?
4. Why is creation of Multimedia Resource Centres done at a snail-like speed?
5. How can the Distance Education Programme and the Multimedia Resource Programme collaborate?

Set 4: Interview Guide for the experts.

1. What do you think are the major drawbacks for digitalising education in Cameroon?
2. What do you think can be done to mitigate these drawbacks?
3. What do you think are the drawbacks of the following programmes: Distance Education and Multimedia resource centre?
4. Do you think a centralised EMIS is better over siloed efforts?
5. What do you think about in-service and preservice training as related to the digitalisation of Secondary Education?
6. What do you think can be done to reduce the resistance of personnels in accepting this new way of working?

Appendix 2: Performance contract between the regional delegate for centre region and the principals of the centre region

REPUBLIQUE DU CAMEROUN
Paix - Travail - Patrie
MINISTERE DES ENSEIGNEMENTS SECONDAIRES
DELEGATION REGIONALE DU CENTRE

REPUBLIC OF CAMEROON
Peace - Work - Fatherland
MINISTRY OF SECONDARY EDUCATION
CENTRE REGIONAL DELEGATION

CONTRAT DE PERFORMANCE ENTRE LA DELEGATION REGIONALE ET LES ETABLISSEMENTS PUBLICS S/C DELEGATION DEPARTEMENTALE

KIT MINIMAL DE DIGITALISATION POUR LE PROCESSUS D'ENSEIGNEMENT DES ETABLISSEMENTS SECONDAIRES

I. ELEMENTS DU KIT

N°	DESIGNATION	CARACTERISTIQUES MINIMALES	OBSERVATIONS
1	Vidéo-projecteur	SVGA (800x600 pixels), HDMI	Se rassurer d'avoir des câbles USB, VGA et HDMI de longueur acceptable.
2	Ordinateur	500GB disque dur, 4GB RAM, 2.2GHz processeur	Un ordinateur portable est conseillé et/ou des tablettes
3	Ecran de projection		Un tableau blanc, toile de projection ou toute surface pouvant permettre la projection de contenu.
4	Salle de classe électrifiée		Salle alimentée en courant électrique.
5	Sources d'énergie alternatives		Groupe électrogène d'une puissance minimale de 1KVA. L'énergie solaire ou éolienne peuvent être envisagées.
6	Webcam		Pas nécessaire si vos ordinateurs possèdent une webcam intégrée.
7	Haut-parleurs		Haut-parleurs externes.
8	Connexion internet		Choisir le fournisseur d'accès qui offre la meilleure qualité de service dans la localité.
9	Rallonges électriques		De préférence avec des para-surtenseurs intégrés.
10	Clé USB	8GB	
11	Microphone		
12	Dispositif de sauvegarde		Un serveur de sauvegarde, un disque dur externe ou tout autre moyen de stockage de données peut être envisagé

NB : Un dispositif home-cinéma peut être utilisé

II. TYPOLOGIES DES ETABLISSEMENTS SCOLAIRES

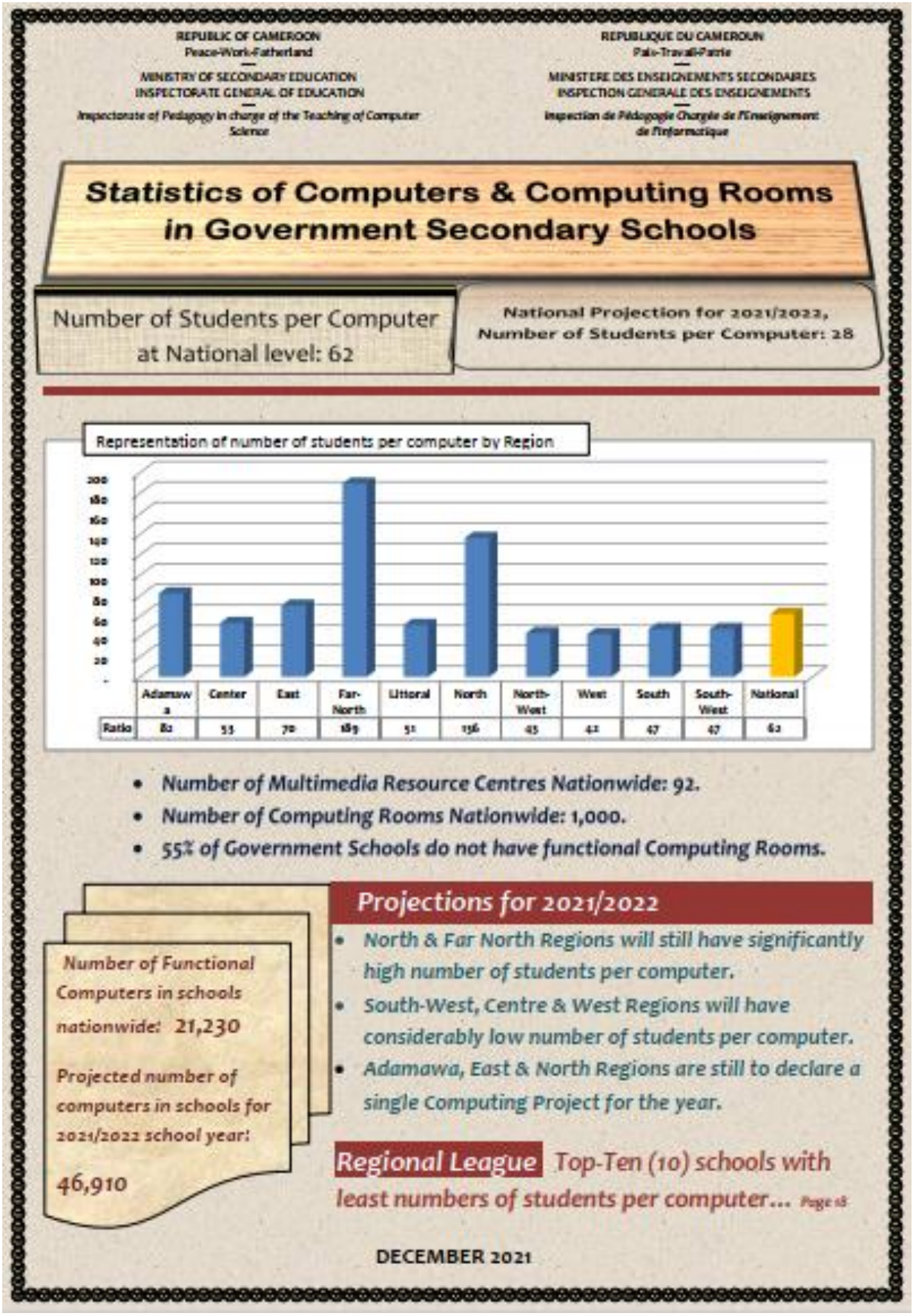
Effectif des élèves	NOMBRE MINIMAL DE KIT	OBSERVATIONS
Moins de 250 élèves	1	
De 251 élèves à 500 élèves	2	
De 501 élèves à 750 élèves	3	
De 751 élèves à 1000 élèves	4	
Au de là de 1000 élèves	4	Plus un kit par tranche de 500

Le Délégué Départemental

Le Chef d'Etablissement,

Le Délégué Régional

Appendix 3: Cover page for report on statistics of computing rooms in secondary education



Appendix 4: Information sheet on computing projects (CP1 form)

REPUBLIC OF CAMEROON
Peace- Work- Fatherland
MINISTRY OF SECONDARY EDUCATION
INSPECTORATE GENERAL OF EDUCATION
Inspectorate of Pedagogy in charge of the Teaching of Computer Science

FORM CP1

RÉPUBLIQUE DU CAMEROUN
Paix – Travail- Patrie
MINISTERE DES ENSEIGNEMENTS SECONDAIRES
INSPECTION GENERALE DES ENSEIGNEMENTS
Inspection de Pédagogie Chargée de l'Enseignement de l'Informatique

INFORMATION SHEET ON COMPUTING PROJECTS

1) CURRENT INFORMATION Government ☐ Private ☐

School:……Region:……

Division:…… Sub Division:……

Name of Principal:…… Principals' contact:……

Tablet: Number of Students per Computer

Enrolment(1)	No. of functional computers(2)	No. of Students per computer (1/2)	No. of Computer Rooms	Category (Cat A, Cat B)

Table2: Characteristics of Computing /Technology resources for school management

Technology			Number Available					
LAN desktops	Stand-alone	Internet	Computer(s)	Printer(s)	Photocopier	Scanner	UPS	others

Table 3: Characteristics of resources in the computing Room

Technology				Number Available					
n-computing	LAN desktops	Stand alone	Internet Connectivity	Computers	Tablets	Printer(s)	V-Projector(s)	Scanner	others

Table 4: Debt owed on Computing Projects

School Year	Amount	Service Provider	Remarks

2) COMPUTING PROJECT FOR THE 2021/2022 SCHOOL YEAR

Table 5: Details of components projected

	Preparing Room	Purchases Installation	Maintenance	Consumables	Seminars Conferences	Salary Teachers	Category (CAT A, B)	Model (SMAS, DMs)	Ratio
(√)									

Table 6: Characteristics of Technology/Computing Resources earmarked for 2021/2022 school year

Technology envisaged					Number previewed					
n-computing	LAN desktops	Stand alone	Internet Con'vity	Solar Panel	Computers	Tablets	Printers	Video Projector	Scanner	others

3) PROJECTION FOR THE NEXT TWO YEARS

Table 6: Elements of Computing Projects envisaged for the next two years

School year	Number of computers	Possible source(s) of finance	Estimated Budget	No. Students per computer	Remarks
20…../20……					
20…../20…….					

Remarks……

……

The principal

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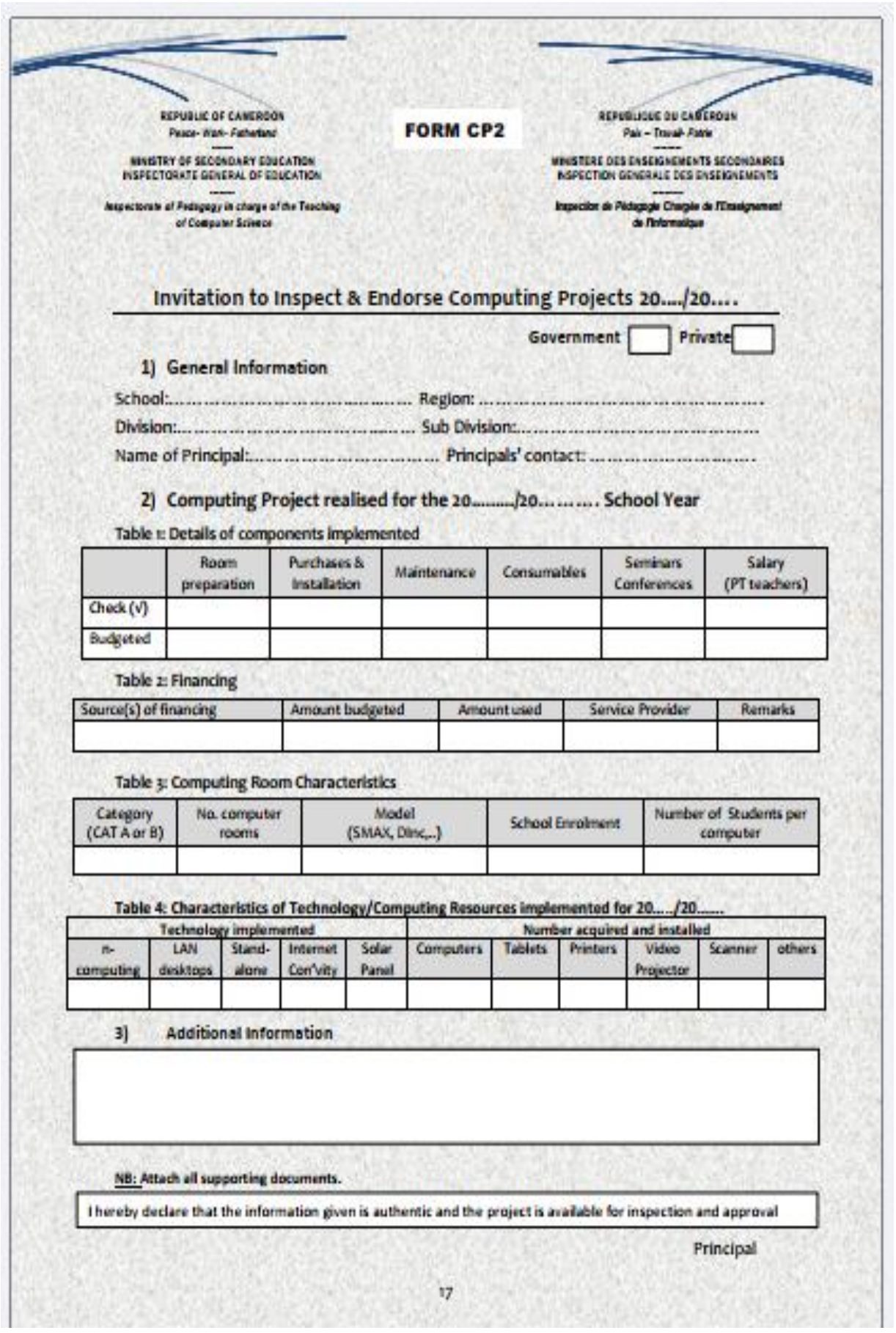
Appendix 5: Invitation to inspect and endorse computing projects (CP2 form)



REPUBLIC OF CAMEROON
Peace- Work- Fatherland

MINISTRY OF SECONDARY EDUCATION
INSPECTORATE GENERAL OF EDUCATION

Inspectorate of Pedagogy in charge of the Teaching of Computer Science

FORM CP2

REPUBLIQUE DU CAMEROUN
Paix – Travail- Patrie

MINISTERE DES ENSEIGNEMENTS SECONDAIRES
INSPECTION GENERALE DES ENSEIGNEMENTS

Inspection de Pédagogie Chargée de l'Enseignement de l'Informatique

Invitation to Inspect & Endorse Computing Projects 20..../20....

Government ☐ Private ☐

1) General Information

School:..... Region: .....

Division:..... Sub Division:.....

Name of Principal:..... Principals' contact: .....

2) Computing Project realised for the 20...../20..... School Year

Table 1: Details of components implemented

	Room preparation	Purchases & Installation	Maintenance	Consumables	Seminars Conferences	Salary (PT teachers)
Check (√)						
Budgeted						

Table 2: Financing

Source(s) of financing	Amount budgeted	Amount used	Service Provider	Remarks

Table 3: Computing Room Characteristics

Category (CAT A or B)	No. computer rooms	Model (SMAX, Dinc,..)	School Enrolment	Number of Students per computer

Table 4: Characteristics of Technology/Computing Resources implemented for 20...../20.....

Technology implemented					Number acquired and installed					
n-computing	LAN desktops	Stand-alone	Internet Con'vity	Solar Panel	Computers	Tablets	Printers	Video Projector	Scanner	others

3) Additional Information

NB: Attach all supporting documents.

I hereby declare that the information given is authentic and the project is available for inspection and approval

Principal

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Appendix 6: Digitalisation endeavours of MINESEC and brief description of each one

Digitalisation Endeavour	Description
MRCs programme	Programme to equip government schools with high-standard computer rooms. Supported by Decision No. 140/B1/1464/MINEDUC/SG/ of February 15th, 2002, which was modified by Decision No. 1233/B1/1464/MINEDUC/SG/ of December 30th, 2002, which was in turn modified by Decision No. 249/06/MINESEC/CAB of May 15th, 2006. The programme was initially managed directly by the presidency and later handed over to MINESEC. The aim of the MRCs is to popularise the use of ICTs, provide access to educational resources that are online and offline, and create and publish educational resources online (Republic of Cameroon, 2006). MRCs are managed by the Inspectorate in charge of the teaching of computer science. (Republic of Cameroon, 2012c).
Setting up IP-INFO	According to Fouda et al. (2013), as cited in Nsolly and Charlotte (2016), the inspectorate in charge of the teaching of computer science was set up in 2002. Its main mission is to coordinate the teaching of computer science and other computing disciplines in secondary education, as clearly stated in Decree No. 2012/267 of June 11, 2012. The establishment of the inspectorate eventually led to the institution of computer science as a subject in the HTTCs. It was integrated into HTTC Yaounde in 2007 and Maroua in 2008 (Nsolly & Charlotte, 2016).
Order No. 3745/D/63/ MINEDUC/CAB of 17/06/2003	This order introduced computing as a subject in the 1st and 2nd cycles of general secondary education and teacher education. Computer science became a compulsory subject in secondary schools in the academic year 2003–2004.
Decision No 24/05/MINESEC/CAB of January 17th, 2005	This decision creates a steering committee for Multimedia Resource Centres in secondary schools.
Decision No 249/06/MINESEC/CAB of May 15th, 2006	This decision reorganises the functioning of Multimedia Resource Centres in Secondary schools in Cameroon. This decision is the most recent policy defining the functioning of MRCs and puts an end to all decisions previously defined for the functioning of MRCs in schools such as Decision No. 1233/B1/1464/MINEDUC/SG of December 30th, 2002.
Creation of MINISEC website	The website https://www.minesec.gov.cm/ is used by MINESEC to provide general information on services offered by MINESEC to the public. Stakeholders can get information and stay updated on events taking place in

	MINESEC via this website. This website also acts as a hub towards other online services offered by MINESEC such as the school map application. The website respects the prescriptions mentioned in Circular No. 007/CAB/PM of August 23, 2000. It has the '. gov.cm' domain and portrays a bilingual face. The website is also constantly updated and feed with salient information. This website contains lots of features such as access to stored files and requesting for certificates which makes some people see it as a web application.
Creation of the TI series	This subject was created in the Francophone subsystem of education by Ministerial Order No. 25/11/MINESEC/CAB of January 13, 2011, to support the GESP in their goal to increase competent IT manpower in Cameroon. An equivalent of the TI series has been created in the English subsystem.
E-registration 2.0	Software created by the Cameroonian General Board of Examinations (CGEB) aimed at managing the registration of GCE candidates and examiners. The GCE Board has other computer systems, like the one for correcting multiple-choice questions and the one used to process results.
MINESECDRH.com	Web application aimed at helping the human resources department of MINESEC perform their duties as defined in article 77 of Decree No. 2012/267 of June 11, 2012. The human resources department of MINESEC is also in charge of the unit managing the SIGIPES project in MINESEC and the professional development of human resources (Republic of Cameroon, 2012c). This application has a variety of functionalities for managing the activities of the human resources department, such as the posting of teachers, the management of internships, schools, and more.
Circular No.12/17/C/MINESEC/CAB of 9 August 2017	Circular to lay down regulatory provisions on the management of the Computing Project in secondary schools and Teacher Training Colleges. Heads of school are expected to prepare and submit a detailed Computing Project to the school council and PTA for appreciation, validation, and adoption at the beginning of each school year. They are expected, amongst others, to: ensure that the Computing Project is integrated into the school project; guarantee rigorous and transparent management of funds allocated to computing projects; ensure full compliance with the requirements and specified standards in order to provide an up-to-date technology environment for students and teachers; and submit a report on the management of the computing project to the Inspectorate of Pedagogy in charge

	of the Teaching of Computing at the end of each term (IP-INFO, 2021a).
Digital Payment of Fees	The Ministry of Secondary Education signed a partnership with telephone operators (ORANGE, MTN) and financial institutions (Afriland First Bank, CAMPOST, Express Union, and recently, EcoBank). The goal of the digital payment of tuition and examination fees is to ease the payment and ensure security, transparency, and traceability in the management of these funds. Inclusion is ensured thanks to the availability of a USSD code, which is being used by parents and students who do not have access to the internet and who lack smart phones to be able to make their payments with ease.
Epim Exam	A web application used by the OBC to code candidate scripts, manage marks, and produce a list of successful candidates.
GNI exam	A software used by DECC to manage the positioning of examiners.
Spider 1 and Spider 2	Spider 1 and Spider 2 are software used by DECC to perform preliminary tasks for the deliberation of exams. Spider 1 is used by the president of the jury, while Spider 2 is used by the vice president of the jury.
Distance Education Programme	This endeavour was taken in 2020 to ensure the continuation of school and the completion of learning hours due to the COVID-19 pandemic. The distance education programme currently has the following elements: a distance education centre where pedagogic resources are validated, recorded, and published online; an electronic platform where lessons are uploaded in an organised manner so that learners, teachers, and other stakeholders can access the resources; an e-counselling helpline where parents and students can access guidance and counselling services; and a Youtube channel where recorded lessons and other events of the Ministry of Secondary Education are uploaded. The centre aims to have a printing press where resources produced will be printed and sent to areas with issues of connectivity and electrical power. The electronic platform for lessons can be accessed via the link: https://minesec-distancelearning.cm/.
Digital school map application	MINESEC has a web application created in 2020 that permits authorised users to provide and modify information on the school map and other activities related to a MINESEC institution. This application can be accessed at https://cartescolaire.cm/login or through the MINESEC website.

Creation of a Computing Project Guide for schools	In 2021, the Inspectorate in charge of the teaching of computing, in line with instructions from the Minister, produced a document to guide school heads on managing computing projects. The purpose of the document is to orient the implementation of Computing Projects along the lines of the new configuration of computing rooms. The guide proposes a set of elements to help in the choice of room layout, models of implementation, characteristics of technology equipment, and sustainable management of Computing projects, thus enabling schools to choose reliable and more performant resources to set up sustainable computing rooms (IP-INFO 2021a).
Service Note 58/22/AR/MINESEC/SG/IP-INFO of January 7th, 2022	Ministerial note recalling the strict application and respect of Circular No.12/17/C/MINESEC/CAB of August 9th, 2017, and the Computing Project Guide.
Revision of teaching syllabus for computing subjects	Order No. 238/23/MINESEC of June 14 to redefine the syllabuses of First cycle General Education was an opportunity for the inspectorate of computer science to ensure IT skills for the next generation are more solid than ever. The teaching syllabuses for computing subjects was revised considering 21st century competencies with reinforced hands-on and novel content areas introduced (IP-INFO, 2021). The new syllabus included key elements such as digital citizenship and computational thinking. This syllabus will be implemented in secondary schools in the 2024–2025 academic year.
MINESEC CELCOM	An Android application for MINESEC agents that permits them to get real-time information on what is happening at MNESEC. They can also access newsletters, press releases, and other documents related to MINESEC. The reporting of state personnel who are not in active service can also be done through this Android application. It can be downloaded through the minesecdrh.cm application or through the link https://minesecdrh.cm/assets/android/celcom_minesec.apk.
Creation of Email for central and Deconcentrated services	In 2021, the IT Unit of MINESEC created an official email address for the central and deconcentrated services of MINESEC, including all the schools. This list was updated in April 2023.